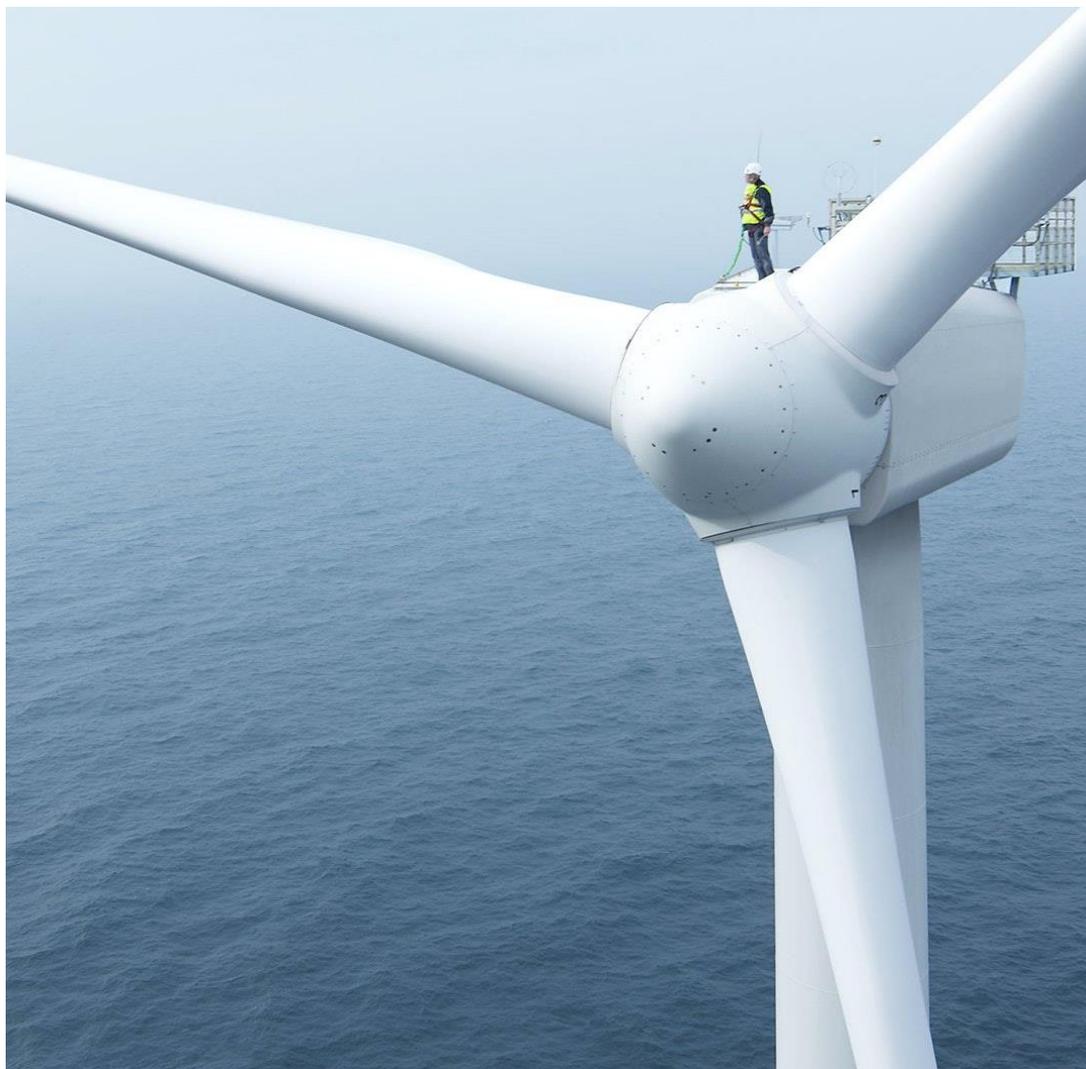


Report on Greenhouse Gas Emissions, and Infrastructure and Supply Chain Opportunities as it Relates to the Deployment of Offshore Wind in the Gulf of Maine



Prepared by the New Hampshire Departments of Energy, Environmental
Services, and Business and Economic Affairs

February 2022

This page intentionally left blank.



STATE OF NEW HAMPSHIRE
OFFICE OF THE GOVERNOR

CHRISTOPHER T. SUNUNU
Governor

Dear Granite Staters,

New Hampshire is extremely fortunate to have wonderful natural resources and some of the most beautiful landscapes in the country. The state's residents value these resources and the high quality of life we enjoy because of them and the benefits they provide to our economy.

Striking the right balance of protecting these natural resources while investing in new infrastructure and other economic development projects is essential to New Hampshire's future. Also vital is increasing the state's energy supply and finding new energy resources to supplement existing energy sources.

One potential option to achieve these public policy goals is the deployment of offshore wind in the Gulf of Maine, which has the potential to be an abundant source of renewable energy that can be generated at scale. Due to the state's port facilities and transmission infrastructure, New Hampshire is uniquely situated to benefit from this new industry in ways that will attract investment, boost the state's economy, and create good paying jobs.

Equally as important is the need to ensure this new industry does not unduly burden existing commercial and recreational maritime activities in the Gulf of Maine, including New Hampshire's commercial fishing industry.

To begin the process of exploring these opportunities and identifying potential impacts, in January 2019 I requested the Bureau of Ocean Energy Management (BOEM), the federal agency responsible for approving offshore wind projects, establish an offshore renewable energy task force for the Gulf of Maine, in regional partnership with Massachusetts and Maine. This request was accepted by BOEM and the first meeting of the Gulf of Maine Intergovernmental Renewable Energy Task Force was held in December 2019.

I also want to acknowledge the work of the Commission on Offshore Wind and Port Development, which was established during the 2020 session of the NH General Court and has been meeting with residents and stakeholders over the last two years.

To supplement these efforts, I issued Executive Order 2021-03 which asked the NH Department of Energy (DOE), the NH Department of Environmental Services (DES), and the NH Department of Business and Economic Affairs (BEA) to issue a report on the greenhouse gas reduction potential of offshore wind, the status of New Hampshire's existing port and coastal transmission infrastructure, and opportunities for New Hampshire to attract offshore wind supply chain operations to New Hampshire.

These state agencies, in collaboration with the NH Port Authority, the NH Sea Grant, and other contributors, compiled this report to provide the historical and forward looking greenhouse gas

reduction potential of offshore wind in the Gulf of Maine and a status overview of New Hampshire's existing port infrastructure, coastal transmission infrastructure, and opportunities to attract offshore wind supply chain operations to New Hampshire.

As the public debate on the potential deployment of offshore wind in the Gulf of Maine continues, I hope this report is a valuable resource for all stakeholders about the assets New Hampshire brings to the table in the form of port and transmission infrastructure and the role the state's workforce can play in supply chain operations, construction, and maintenance of offshore wind infrastructure.

The report is also a reminder that we must be respectful of the existing industries and recreational activities that rely on access to the Gulf of Maine so they can continue to thrive and grow with as minimum an impact as possible from the deployment of offshore wind.

Offshore wind has the potential to realize many positive economic, energy, and environmental impacts for New Hampshire and our neighboring states, but a balanced approach to public policy has always served New Hampshire well and that approach is critical as we evaluate the potential for offshore wind in the Gulf of Maine.

Sincerely,



Christopher T. Sununu
Governor

ACRONYMS

BEA	New Hampshire Department of Business and Economic Affairs
BOEM	U.S. Bureau of Ocean Energy Management
GDP	Gross Domestic Product
GHG	Green House Gas
GSP	GSP Schiller, LLC
ISO-NE	ISO-New England
LMP	Locational Marginal Price
MARCO	Mid-Atlantic Regional Ocean Council
NERC	North American Electric Reliability Corporation
NESCOE	New England State Committee on Electricity
NHDES	New Hampshire Department of Environment Services
NOAA	National Oceanic and Atmospheric Administration
NPCC	Northeast Power Coordinating Council
NROC	Northeast Regional Ocean Council
OSI	New Hampshire Office of Strategic Initiatives
OSW Commission	New Hampshire Commission to Study Offshore Wind and Port Development
PJM	PJM Interconnection, LLC
POI	Points of Interconnection
PTF	Pool Transmission Facilities
RODA	Responsible Offshore Development Alliance
UNH	University of New Hampshire

TABLE OF CONTENTS

- Preface.....1
- Introduction.....2
 - Offshore Wind in the Gulf of Maine2
 - BOEM Gulf of Maine Intergovernmental Renewable Energy Task Force2
 - New Hampshire Commission to Study Offshore Wind and Port Development.....3
 - East Coast States Joint Effort Facilitated by Special Initiative on Offshore Wind3
 - New England and Northeast Offshore Wind Development Projects3
 - Block Island Wind Farm (Rhode Island).....3
 - Vineyard Wind 1 (Massachusetts).....4
 - Vineyard Wind South (Massachusetts and Connecticut)4
 - South Fork Wind Farm (New York and Rhode Island)5
 - Sunrise Wind Farm (New York)5
 - New England Aqua Ventus (Maine).....5
- 1 New Hampshire Greenhouse Gas Emissions: Historical and Potential7
 - 1.1 Introduction.....7
 - 1.1.1 Summary.....7
 - 1.1.2 New Hampshire’s GHG Inventory.....7
 - 1.2 Historical GHG Emissions.....8
 - 1.2.1 GHG Snapshots8
 - 1.2.2 Changing Energy Consumption 10
 - 1.2.3 The Cause of Emissions Reductions..... 11
 - 1.3 Projected GHG Emissions 13
 - 1.3.1 2014 Energy Strategy Energy Modeling 13
 - 1.3.2 ISO-NE Modeling..... 14
 - 1.3.3 GHG Emission Reduction Targets 15
 - 1.4 Potential GHG Emissions 15
 - 1.4.1 Electrification..... 15
 - 1.4.2 Complementary Role of Wind 16
- 2 Port Infrastructure..... 18
 - 2.1 Current Infrastructure 18
 - Market Street Marine Terminal..... 19
 - Schiller Power Station..... 20

Portsmouth Naval Shipyard.....	21
3 Coastal Transmission Infrastructure.....	22
3.1 Background on Issue.....	22
3.2 Gulf of Maine Transmission Issues and Opportunities.....	22
3.3 New Hampshire Transmission Challenges and Onshoring Opportunities.....	23
3.4 Regional Transmission Issues and Opportunities.....	26
Generator Lead Line/Radial Approach	26
Coordinated Approaches.....	27
New Jersey Competition Approach	27
3.5 Future Needs	27
4 Offshore Wind Supply Chain.....	29
4.1 Supply Chain Opportunities.....	29
Appendix A – Executive Orders	30
Appendix B – Coastal Offshore Wind Area Maps	35
Appendix C – Power Advisory Report: New Hampshire Transmission and Implications of Offshore Wind in the Gulf of Maine.....	39
Appendix D – State of NH Seafood Harvesting Industry	36

PREFACE

Executive Order 2021-03 (Issued on March 1, 2021)

Offshore Wind Report

An order amending and restating Executive Order 2019-06 (An order preparing New Hampshire for future offshore wind development and the Bureau of Ocean Energy Management (BOEM) Offshore Renewable Energy Task Force).

The following studies shall be completed no later than October 31, 2021, and shall be submitted to the Governor, Speaker of the House, Senate President, Public Utilities Commission and the chairs of the relevant committees of the General Court. The Office of Strategic Initiatives (OSI), the Department of Environmental Services (NHDES), and the Department of Business and Economic Affairs (BEA) shall jointly study and report on:

- a. The historical and forward-looking greenhouse gas reduction potential of offshore wind in the Gulf of Maine at varying levels of system installations.
- b. New Hampshire's existing port infrastructure, coastal transmission infrastructure, and opportunities for New Hampshire to attract offshore wind supply chain operations to New Hampshire.

Report Background

This two-part report provides the data and analysis requested for in the Governor's Executive Orders of December 2019 and March 2021.

INTRODUCTION

This report covers a variety of topics relating to the deployment of offshore wind in the Gulf of Maine and in other parts of the Northeast with the intention of providing objective data and information to New Hampshire's elected officials, businesses, and residents that will contribute positively to the on-going public policy debate on the subject of offshore wind in the Gulf of Maine.

Offshore Wind in the Gulf of Maine

The National Grid Group defines offshore wind as: "Offshore wind power or offshore wind energy is the energy taken from the force of the winds out at sea, transformed into electricity and supplied into the electricity network onshore."

The viability of the deployment of offshore wind in the Gulf of Maine has been in discussion for many years. As the industry has matured and technologies improved, the call to take a more substantial review of the potential for offshore wind in the Gulf of Maine has increased.

The motivations to explore the potential of offshore wind include:

- Offshore wind is a clean and renewable source of energy generation, which could result in emissions reductions in the region.
- Increasing energy supply is a priority for New Hampshire; offshore wind in the Gulf of Maine has the potential to be an abundant source of energy that is capable of being generated at scale.
- Because of the port and transmission infrastructure, New Hampshire is uniquely positioned to potentially benefit from this new industry in ways that will attract investment, boost the State's economy, and create good paying jobs.

BOEM Gulf of Maine Intergovernmental Renewable Energy Task Force

In January 2019, New Hampshire requested BOEM establish an offshore renewable energy task force for the Gulf of Maine that would include representation from New Hampshire, Massachusetts and Maine. This request resulted in the chartering of the BOEM Gulf of Maine Intergovernmental Renewable Energy Task Force to facilitate coordination and consultation related to renewable energy planning activities on the Outer Continental Shelf in the Gulf of Maine.

On December 3, 2019, Governor Chris Sununu issued Executive Order 2019-06, which created four advisory boards to be chaired by state agency department heads, and required OSI, NHDES and BEA to issue a report on the greenhouse gas reduction potential of offshore wind and the status of New Hampshire's existing port and coastal transmission infrastructure and opportunities for New Hampshire to attract offshore wind supply chain operations to New Hampshire.

On December 12, 2019, the first public meeting of the Task Force was held in the University of New Hampshire's (UNH's) Durham Campus. The purpose of this meeting was to:

- Facilitate coordination among federal, state, local and tribal governments regarding the wind energy leasing process on the Outer Continental Shelf in the Gulf of Maine.
- Share information about existing Gulf of Maine activities and marine conditions.
- Provide updates on regional offshore wind goals and developer activities.

Unfortunately, the challenges associated with responding to the COVID-19 pandemic resulted in the four advisory boards not being able to meet. On March 1, 2021, Governor Sununu issued an updated Executive Order extending the deadline for the state agencies to issue the requested reports to October 31, 2021. The role of the advisory boards is being fulfilled by the New Hampshire Commission to Study Offshore Wind and Port Development, which was able to meet remotely during the restrictions on official and public meetings due to COVID response efforts.

This report serves as the agencies' response to the requirement in the Governor's Executive Orders of an offshore wind report.

[BOEM Gulf of Maine Intergovernmental Renewable Energy Task Force Webpage](#)

New Hampshire Commission to Study Offshore Wind and Port Development

During the 2020 Session of the New Hampshire General Court, the State Legislature passed and the Governor signed into law House Bill 1245, which established the Commission to Study Offshore Wind and Port Development (OSW Commission), which is tasked with many of the same activities as those assigned to the four advisory boards created by Executive Order 2019-06.

The OSW Commission meets monthly and is made up of representatives from government, the business community (including representatives from New Hampshire's commercial fishing industry), and labor unions.

[New Hampshire Commission to Study Offshore Wind and Port Development Website](#)

East Coast States Joint Effort Facilitated by Special Initiative on Offshore Wind

The Northeast and Mid-Atlantic Coastal States are currently engaged in early conversations to address the important issue of compensatory mitigation, or impact fees (the preferred term of the Responsible Offshore Development Alliance (RODA)) for fisheries and other commercial and recreational maritime activities. These preliminary intergovernmental conversations involve the states, BOEM, National Oceanic and Atmospheric Administration (NOAA) and RODA.

This effort is being coordinated by the Special Initiative on Offshore Wind, an independent project at the University of Delaware that supports the advancement of offshore wind.

At this stage, the states wish to learn from each other and identify common needs and interests. The states recognize the importance of involving their fishing industries and fishing communities as well as offshore wind developers in this conversation and intend to promote, support, and be involved in engagement processes that meaningfully and substantively do so.

New England and Northeast Offshore Wind Development Projects

Block Island Wind Farm (Rhode Island)

Block Island is a 30 MW, five-turbine offshore wind facility located approximately three-miles southeast of Block Island and was the first commercial offshore wind farm in the United States.

Project Timeline:

- September 2014 – Final Federal Approval Granted
- March 2015 – Financial Closure.
- July 2015 – Installation of First 400 Ton Steel Turbine Foundation.
- First Half of 2016 – Submarine Cable Installation.

- Second Half of 2016 – Turbine Installation.
- December 2016 – Wind Farm Was Fully Operational.

Project Information:

- Created 300 construction Jobs.
- The wind farm generates approximately 125 GW of energy per year, serving approximately 17,000 households and connecting Block Island to the mainland grid for the first time.
- Reduced electricity costs on Block Island by 40%.
- Reduces CO₂ emissions by 40,000 tons annually and is projected to offset 800,000 tons of emissions during its estimated operational life, the equivalent of 150,000 vehicles.
- Replaced five diesel generators, which had burned one million gallons of fuel annually.

Vineyard Wind 1 (Massachusetts)

Vineyard Wind is currently building the nation's first utility-scale offshore wind energy project, approximately 15 miles south of Martha's Vineyard and Nantucket, off the coast of Massachusetts on the southern outer continental shelf.

Project Timeline:

- January 2015 – BOEM held a public auction for offshore wind development areas.
- August 2016 – Legislation requiring Massachusetts to solicit proposals for up to 1,600 MWh of offshore wind power by 2027 becomes law.
- December 2017 to May 2021 – Project completes the Federal and State Permitting Process
- Installation of cables and construction begins in 2022 and is expected to be operational in 2023.

Project Information:

- Projected to generate 800 MWh of electricity for 400,000 residences and businesses annually.
- Electricity will be transmitted to the ISO-NE Power Grid at an onshore substation in Hyannis.
- Projected to reduce 1.68 million tons of CO₂ emissions annually, equal to 325,000 vehicles.
- The wind farm will consist of 62 turbines, spaced one nautical mile apart from each other.
- Two submarine cables buried up to six feet below the seafloor will be installed along the route.
- An estimated \$3.7 billion in energy related cost savings are projected over the wind farm's Life.
- Entered into a historic agreement to protect critically endangered North Atlantic right whales.

Vineyard Wind South (Massachusetts and Connecticut)

Vineyard Wind South is planned to have two phases, with Phase 1 being called the Park City Wind Project. The integration point into the power grid will be located in Massachusetts but the purchasing agreement is with Connecticut. The project is in the beginning stages of both BOEM's federal permitting process and Massachusetts's state permitting process, with an estimated start of construction sometime in 2023. The planning and permitting process for Phase 2 of the project has not begun.

Project Information (Phases 1 and 2):

- An estimated 130 turbines, with 50-62 being planned for Phase 1 and 64-79 planned for Phase 2.
- Once fully operational, projected to generate 2,000-2,300 MWh of electricity.
- The identified power grid interconnection point is West Barnstable, MA.
- Turbine spacing will be one nautical mile by one nautical mile across all lease areas.
- Projected to reduce approximately 3.95 million tons of CO₂ emissions annually, the equivalent of 780,000 vehicles.

South Fork Wind Farm (New York and Rhode Island)

South Fork Wind will be New York's first offshore wind farm. It is a 12-turbine project projected to generate 132 MWh of electricity to power 70,000 homes in the Town of East Hampton, the equivalent of emissions from 60,000 cars.

Project Information:

- 50/50 Partnership between Ørsted and Eversource.
- Construction begins in 2022 and is expected to be fully operational in 2023.
- Located 35 Miles East of Montauk Point.

Sunrise Wind Farm (New York)

Sunrise Wind Farm will be New York's largest wind farm, projected to generate 924 MWh of electricity to power approximately 600,000 homes.

Project Information:

- 50/50 Partnership between Ørsted and Eversource, with support from Con Edison and the New York Power Authority.
- This project is currently still in the permitting process but is estimated to be operational in 2025.
- Located 30 miles east of Montauk Point with a planned interconnection point at Holbrook and West-Bus substation in Brookhaven within the Long Island Power service territory.

New England Aqua Ventus (Maine)

New England Aqua Ventus is part of Maine's Research Array Project, which is a floating offshore wind pilot project located off the shores of Maine. The project will utilize floating semisubmersible concrete hulls rather than traditional wind turbines used in most currently deployed offshore wind farms.

Designed by the Advanced Structures and Composites Center at the University of Maine, the hulls are secured by three mooring lines anchored to the seabed connected to the power grid through cables.

The project is estimated to create 1,150 jobs and projected to generate approximately 11 MWh of electricity.

Overview of the project from the State of Maine's website:

"The State of Maine is pursuing a federal lease for a research array in the Gulf of Maine. This state-led approach ensures the fishing industry and other interested stakeholders have a clear "seat at the table" to explore offshore wind, identify siting of a limited research project area, and develop and advance the key research questions needed to understand early as floating offshore wind expands. Due to its deep waters, generating wind energy in the Gulf of Maine will likely come from floating offshore wind turbines, a technology that is still advancing and requires additional scientific study about potential effects on fisheries and the marine environment. Governor Mills has directed the Governor's Energy Office to work directly with the fishing industry, and other interested stakeholders, including federal and state partners, to determine a specific location for the research array. The state is fully committed to engaging stakeholders, in particular and importantly commercial fishing interests who are an integral part of both the state's overall economy as well as the local economy in Maine's coastal communities."

Report A – Greenhouse Gas Emissions

1 NEW HAMPSHIRE GREENHOUSE GAS EMISSIONS: HISTORICAL AND POTENTIAL

1.1 Introduction

1.1.1 Summary

New Hampshire's greenhouse gas (GHG) emission levels have fallen markedly since they peaked in 2004 and are currently lower than the GHG emissions reduction path proposed by Climate Change Policy Task Force in the 2009 New Hampshire Climate Action Plan (Plan). The Plan was developed by a diverse task force with representation from New Hampshire's utilities, businesses, the construction industry, the transportation industry, and public interests and was supported by state agencies.

However, New Hampshire's GHG emissions levels are projected to remain at current levels through 2030 absent new policies that will continue to reduce GHG emission levels. The development of offshore wind energy in the Gulf of Maine, whether coming ashore in New Hampshire or another New England state, has the potential to further reduce GHG emissions in New Hampshire, as well as the entire New England region.

1.1.2 New Hampshire's GHG Inventory

New Hampshire's GHG emissions levels are inventoried annually by NHDES, which tracks the six main GHGs listed below with their relative contribution to total GHG emissions in 2019. The total GHG emissions in 2019 was 15.8 million metric tons of CO₂-equivalents (MMTCO₂e).

New Hampshire GHG Emissions by Gas for 2019:

- Carbon dioxide (CO₂) – 92%
- Nitrous oxide (N₂O) – 4%
- Methane (CH₄) – 1%
- Industrial Process Gases – 3%
 - Hydrofluorocarbons (HFCs)
 - Perfluorocarbons (PFCs)
 - Sulfur hexafluoride (SF₆)

CO₂ emissions make up the vast majority of New Hampshire's GHG emissions, most of which are generated by burning fossil fuels (oil, coal, natural gas) to produce heat, electricity, and power motor vehicles. The synthetic gases (HFCs, PFCs, and SF₆) are generated during industrial processes. Methane (CH₄) is generated by the decomposition of organic wastes in landfills, during the wastewater treatment process, and from livestock. Nitrous oxide (N₂O) is generated from the production and use of fertilizers, and from transportation sources.¹

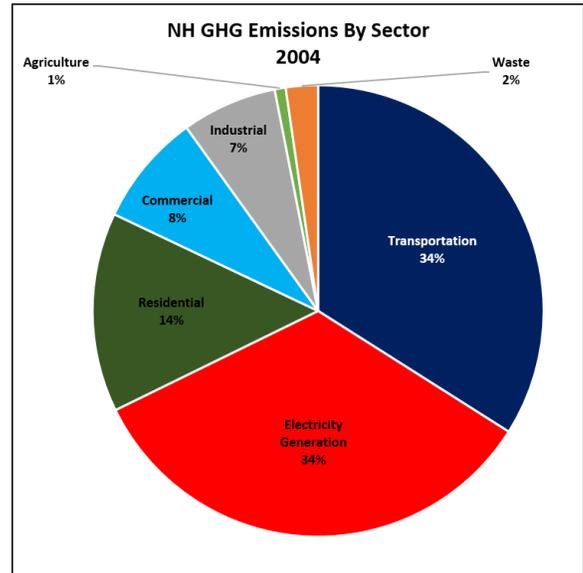
¹ Data Source: 2019 NH GHG Emissions Inventory: US Energy Information Administration, US EPA Data, RGGI Inc.; NHDES Analysis. July 2021.

1.2 Historical GHG Emissions

1.2.1 GHG Snapshots

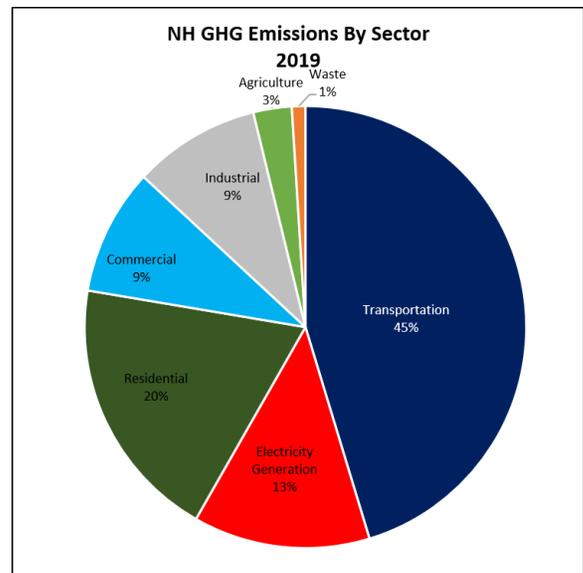
While the contribution of each of the individual GHGs tracked in the New Hampshire inventory has remained largely the same over the past three decades, the contribution of each sector has shifted significantly. In 2004, the year that New Hampshire emissions peaked at 23.7 MMTCO₂e, the transportation, electric and building sectors each contributed roughly one-third of all emissions.²

1. Transportation (34.0%)
2. Electric Generation (33.8%)
3. Residential (14.3%)
4. Commercial (8.0%)
5. Industry (6.8%)
6. Waste and Wastewater (2.9%)
7. Agriculture (1%)



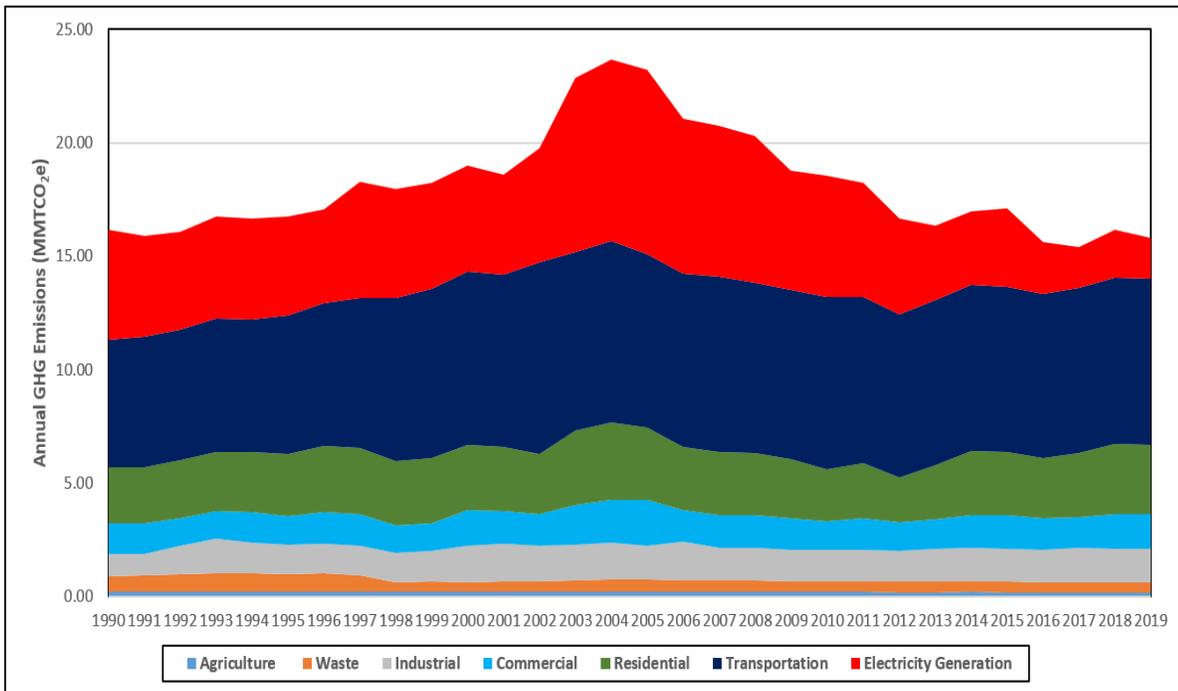
By 2019, overall emissions had fallen by 33% to 15.8 MMTCO₂e, with the transportation sector contributing almost half, the building sector nearly 40%, and the electric sector had fallen to 11%.

1. Transportation (46.5%)
2. Electric Generation (11.3%)
3. Residential (19.3%)
4. Industry (9.5%)
5. Commercial (9.5%)
6. Waste and Wastewater (2.9%)
7. Agriculture (1%)

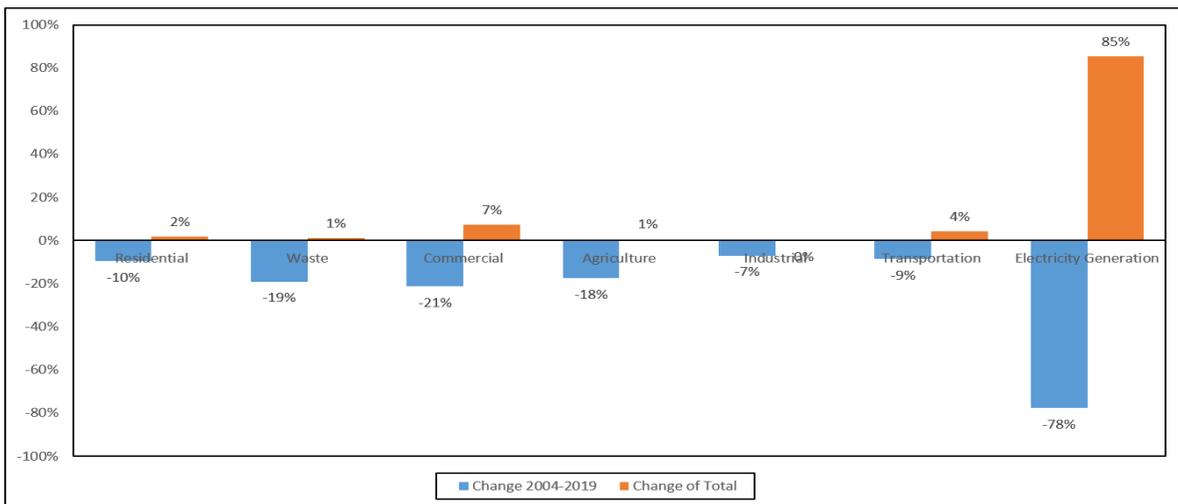


² Data Source: 2019 New Hampshire GHG Emissions Inventory: US Energy Information Administration, US EPA Data, RGGI Inc.; NHDES Analysis. July 2021.

Looking at the GHG emissions over the entire inventory period from 1990 to 2019 allows the changes in emissions to be followed more fully.



Since the 2004 peak, GHG emissions have trended consistently lower, falling by one-third and are in fact 2.3% below 1990 levels, the established baseline year in the inventory.³ The electric sector GHG emissions fell nearly 80% since 2004, representing almost 85% of total reductions across that time. Other sectors declined through 2012,⁴ and have remained flat or have begun to slightly rise.⁵



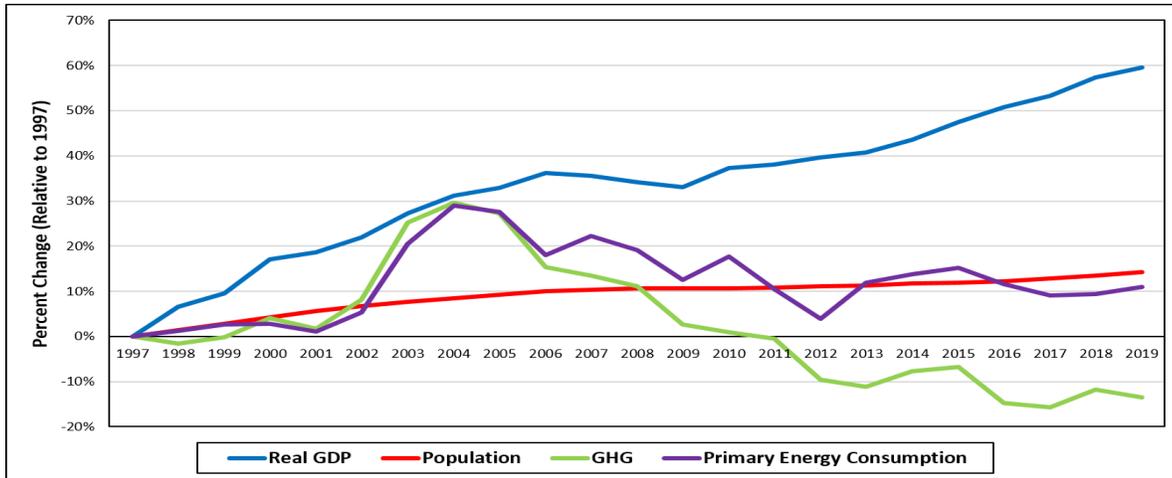
³ Data Source: 2019 New Hampshire GHG Emissions Inventory: US Energy Information Administration, US EPA Data, RGGI Inc.; NHDES Analysis. July 2021.

⁴ Emissions through 2011 were likely lower as a result of the Recession, while 2012 energy consumption, and therefore GHG emissions, were deeply affected by a historically abrupt end to winter as March 2012 experienced extended periods of days over 80 degree Fahrenheit.

⁵ Data Source: 2019 New Hampshire GHG Emissions Inventory: US Energy Information Administration, US EPA Data, RGGI Inc.; NHDES Analysis. July 2021.

1.2.2 Changing Energy Consumption

A deeper analysis of New Hampshire's primary⁶ and secondary⁷ energy consumption shows some apparent conflicting data points. Even as total GHG emissions in New Hampshire fell by one-third, and electric sector emissions fell by more than 80%, New Hampshire's total primary energy consumption only fell by 14% and the electric sector only fell by 23.4%.



Over the past 30 years, New Hampshire has experienced a net economic, public health and environmental benefit as total primary energy-consumption and GHG emissions have fallen. Between 1997 and 2019, the longest period for which consistent data is readily available, New Hampshire saw its Gross Domestic Product (GDP) steadily rise, pausing only briefly during the 2008 Recession, and ultimately growing by almost 60% in two decades.⁸ Across that same time period, New Hampshire's population grew by just over 10%.⁹

Meanwhile, and as noted above, total primary energy consumption and GHG emissions underwent more extreme changes, rising quite rapidly to peak in 2004 before falling through 2019.¹⁰ While New Hampshire's total primary-energy use fell between 2004 and 2019, the total end-use energy consumption across all sectors,¹¹ inclusive of retail electricity consumption, was similar to the total increase in population compared to 1997.

⁶ Primary energy consumption refers to the fuels consumed at their first point of use rather than final point of use (i.e., accounts for nuclear and natural gas fuels consumed to generate electricity but not the electricity used by homes and businesses).

⁷ In contrast to primary energy, secondary energy consumption does not include the energy consumed by the electric sector in New Hampshire, but instead factors in the retail electricity consumption in residential, commercial, industrial, and transportation sectors.

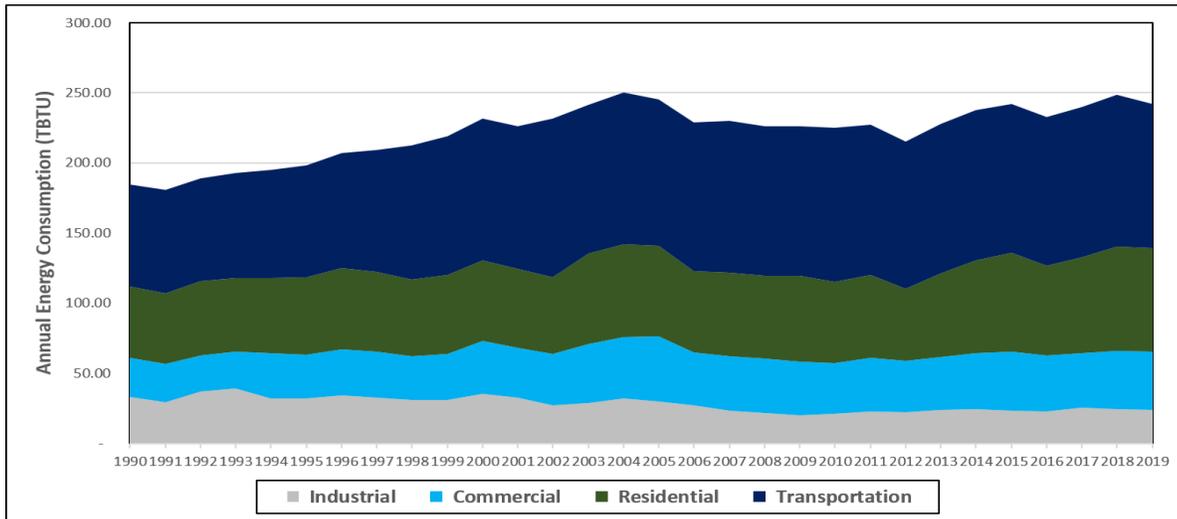
⁸ Federal Reserve Economic Data, <https://fred.stlouisfed.org/series/NHRGSP>; US DOE EIA State Energy Data System (SEDS): NH 1960-2019, <https://www.eia.gov/state/seds/seds-data-complete.php?sid=NH>; and US Census Bureau; NHDES Analysis. August 2021.

⁹ US Census Bureau.

¹⁰ The low in primary energy consumption did occur in 2012, however, this was primarily driven by very warm temperatures in March of 2012 which reduced and even eliminated heating load for a portion of the end of winter and beginning of spring.

¹¹ In contrast to primary energy, as defined above, total end-use energy does not include the energy consumed by the electric sector in New Hampshire, but instead factors in the retail electricity consumption in residential, commercial, industrial and transportation sectors.

Despite that overall gain in primary energy consumption, GHG emissions were more than 10% below 1997 levels by the end of 2019. This largely demonstrates the increased decoupling that as occurred between New Hampshire’s economy and its consumption of energy in general, and fossil fuels in particular.



New Hampshire’s total end-use energy consumption, which includes retail electric sales, fell 2.3% since it peaked in 2004 and total end-use energy consumption grew by 12% over the last decade coming out of the 2008 Recession. This post-recession growth occurred exclusively within the buildings sector as the transportation sector remained relatively flat over the whole timeframe. The residential sector increased consumption by more than 40% from 2012 on, and the commercial and industrial sectors each increased energy consumption by more than 9%.¹² New Hampshire’s emissions are falling, but the economy is consuming slightly more energy.

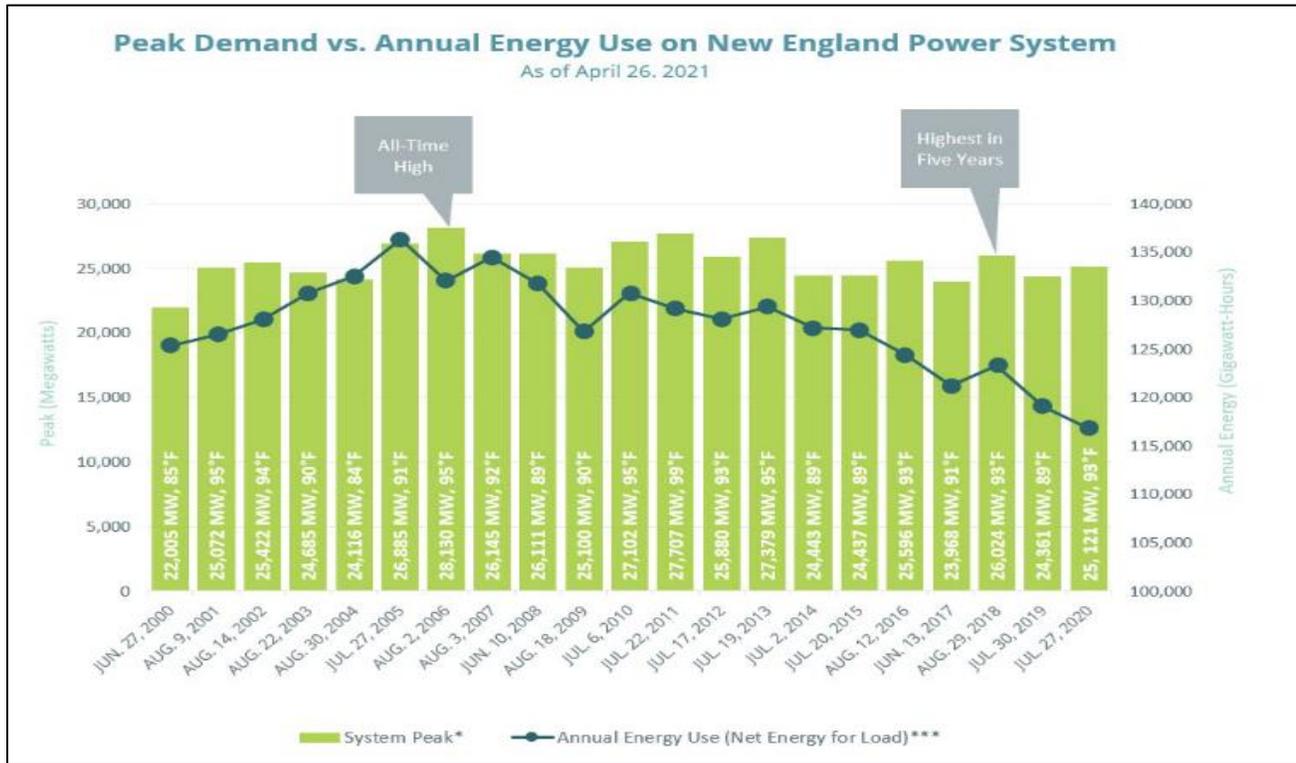
1.2.3 The Cause of Emissions Reductions

To understand the falling GHG emissions and the recent increase in end-use energy consumption, New Hampshire’s GHG inventory and energy data needs to be considered as part of the regional energy system. New Hampshire’s pattern of primary and end-use energy consumption and GHG emissions over the past three decades has been influenced by several interrelated variables including in-state and regional population growth, improvements in overall energy efficiency and conservation, and increased deployment of renewable energy generation technology. The factors collectively influenced total annual, seasonal, and daily electricity consumption and demand, and therefore power generation.

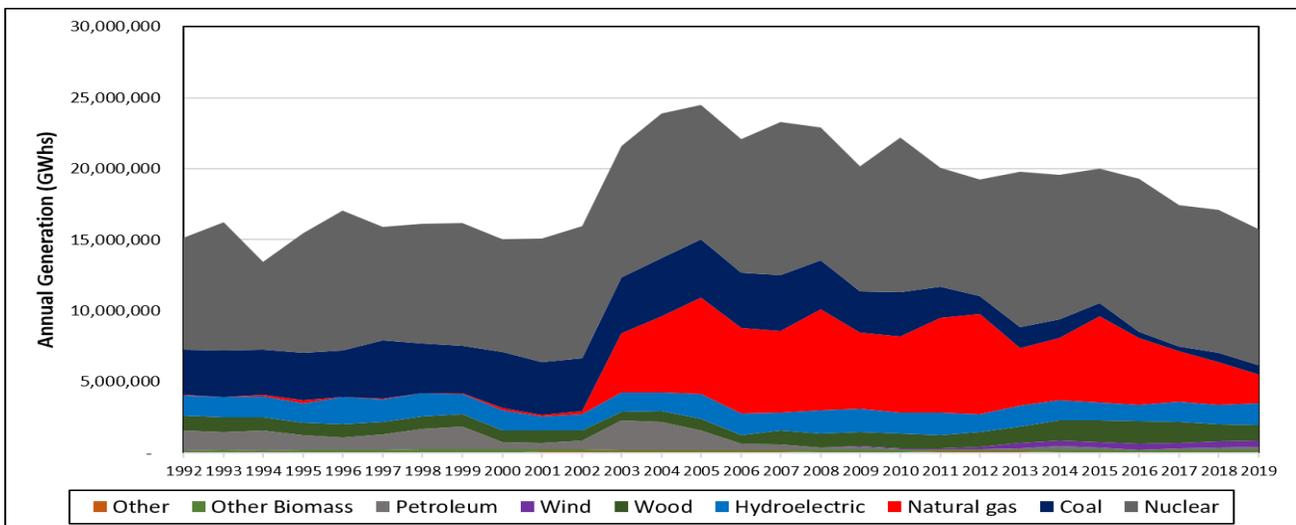
In exploring how New Hampshire’s GHG emissions fell while total energy consumption increased, it’s necessary to look at energy consumption as a part of the New England region. The six New England states form an interconnected grid that allows all the electricity generated within their borders to be shared within the region, as needed, based on price and supply, a process overseen by the regional grid operator, ISO-New England (ISO-NE). The power that is generated in New Hampshire may be consumed in-state, but it can also be exported to other states that need extra power when there is a surplus in New Hampshire. In general, New Hampshire power generators produce twice the amount of electricity than is consumed. The remaining power is used to meet the overall power demand of the other New England states.

¹² Data Source: 2019 New Hampshire GHG Emissions Inventory: US Energy Information Administration, US EPA Data, RGGI Inc.; NHDES Analysis. July 2021.

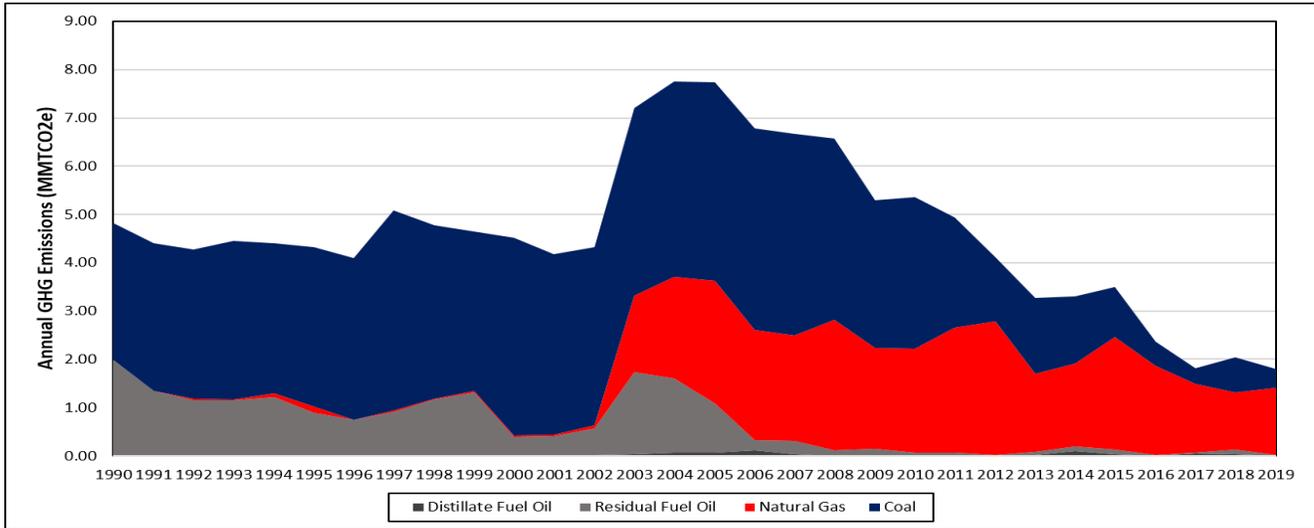
However, the interconnected nature of the New England power supply means that as regional power consumption and demand increases or decreases, it can have an impact on how much New Hampshire's power generators are called on to provide power. The ISO-NE region has seen an overall decline in total power consumption as well as a general decline in peak energy demand. This means that more expensive power generation has been called on to provide less and less power over the course of the year, as well as on the very warmest and coldest day when demand is highest.



As a result of the emergence of inexpensive natural gas becoming available within the New England market, this has resulted in coal and oil becoming less cost competitive and running less often. Coal and oil generators in New Hampshire have been providing the region with less and less power as the region's consumption and demand have fallen. Natural gas has emerged as a significant source of supply, nearly supplanting coal entirely. However, as regional consumption and demand has fallen, so too has natural gas-fired generation.



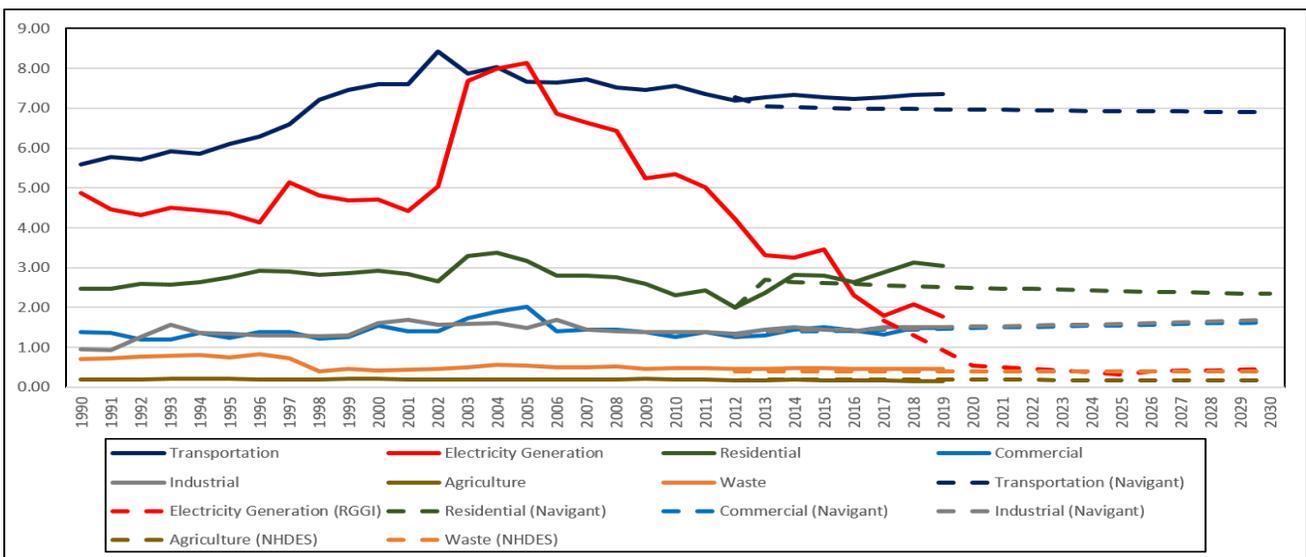
The net effect of the transition from coal to gas was a reduction in emissions, as natural gas emits less than half the CO₂ that coal does to produce the same amount of electricity. As the region's electricity consumption continued to fall, the overall reduction in generation demand has caused them to fall even further. New Hampshire's inventory shows reduction in GHG emissions has fallen further and faster since 2005 than almost every state in the nation.¹³ This has also been partially the result of investments in energy efficiency and renewable energy made by the five other New England states.



1.3 Projected GHG Emissions

1.3.1 2014 Energy Strategy Energy Modeling

New Hampshire energy consumption is exceeding the projections of energy consumption that were made for the 2014 State Energy Strategy in which projections were developed for energy consumption out to 2030. While it was projected that energy consumption across all sectors would be lower than the peak in 2004, when converting those energy projections to GHG emissions, New Hampshire has exceeded those projections.¹⁴



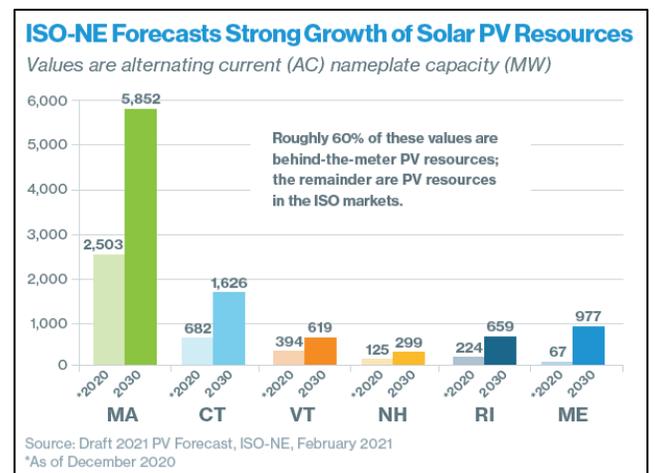
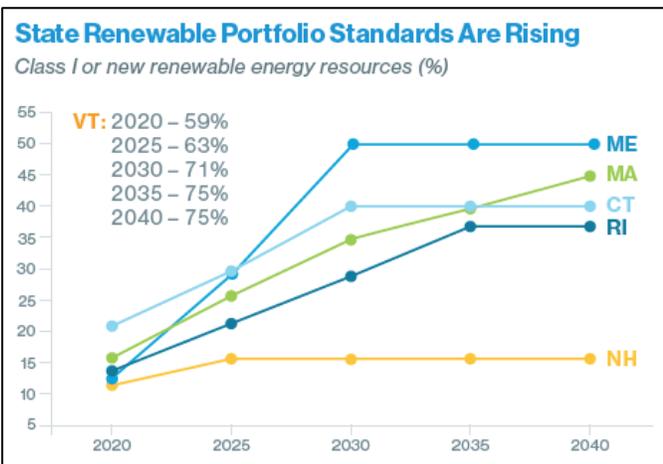
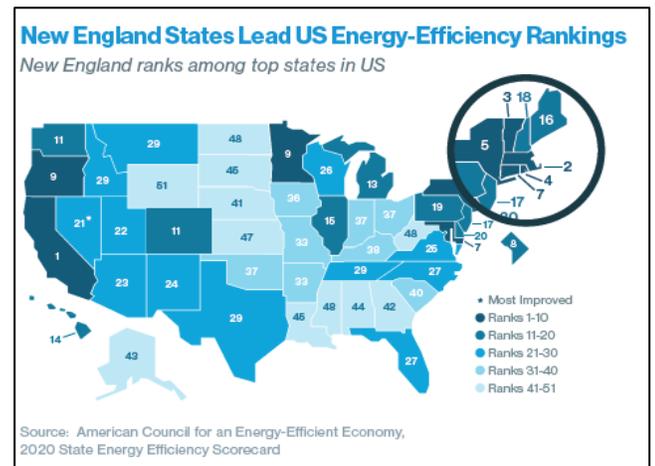
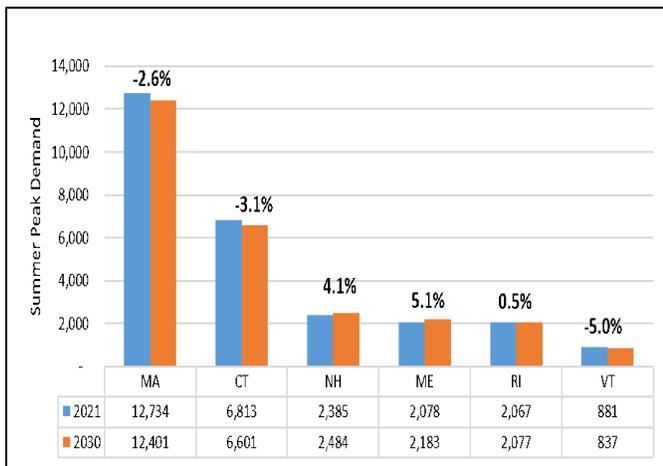
¹³ Saha, D. and Jaeger, J. (2020). *Ranking 41 US States Decoupling Emissions and GDP Growth*, World Resources Institute, <https://www.wri.org/insights/ranking-41-us-states-decoupling-emissions-and-gdp-growth>.

¹⁴ State Energy Strategy, Navigant Consulting Data, 2014; NHDES Analysis 2021.

1.3.2 ISO-NE Modeling

In 2020, ISO-NE projected New Hampshire’s share of the region’s peak summer energy load would rise by 0.2% between 2021 and 2029.¹⁵ However, ISO-NE released updated projections in April 2021 that projected the share of the transmission load is now expected to rise by 0.5%, more than double the increase estimated a year earlier.¹⁶ While this appears to be a modest increase, this increased share in transmission costs, which is determined by a state’s electricity usage, represents a potential increase of \$3.3 million in additional transmission costs for New Hampshire ratepayers between 2021 and 2024.¹⁷

This modeling, which was done with input from each of the state’s electric utilities, as well as other stakeholders, and includes analysis of energy efficiency and renewable energy policies, found that New Hampshire’s projected investments in general lagged those of the other New England states.¹⁸



¹⁵ ISO-NE (2020). *CELT Annual Report 2020*, https://www.iso-ne.com/static-assets/documents/2020/04/2020_celt_report.xlsx, NHDES analysis. June 2021.

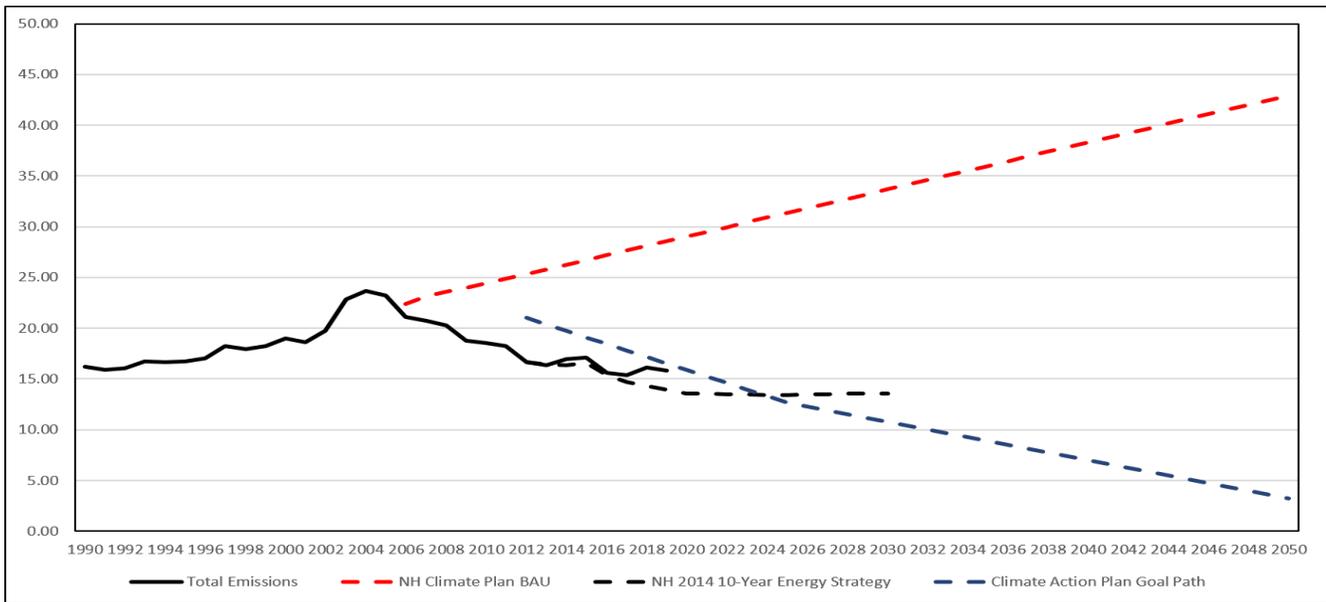
¹⁶ ISO-NE (2020). *CELT Annual Report 2020*, https://www.iso-ne.com/static-assets/documents/2020/04/2020_celt_report.xlsx, and ISO-NE (2021). *Annual CELT Report 2021*, https://www.iso-ne.com/static-assets/documents/2021/04/2021_celt_report.xlsx, NHDES analysis. June 2021.

¹⁷ NHDES analysis of ISO-NE *Annual CELT Report 2020*, and ISO-NE *Annual CELT Report 2021*, in addition to data shared by ISO-NE (personal communication June 7, 2021).

¹⁸ ISO-NE (2021). *New England Power Grid State Profiles 2020–2021*, https://www.iso-ne.com/static-assets/documents/2021/03/new_england_power_grid_state_profiles.pdf.

1.3.3 GHG Emission Reduction Targets

While New Hampshire’s future energy consumption and emissions are not expected to fall as fast as has occurred in the recent past, they have fallen considerably from projections made a decade ago and are roughly in line with the aspirational GHG emissions pathway articulated in the 2009 NH Climate Action Plan. The Plan found that New Hampshire’s GHG emissions, if nothing else changed, would continue to grow and would roughly double between 2005 and 2050. The task force noted that reducing New Hampshire’s emissions out to 2050 by 80% would result in a net economic benefit while maintaining critical natural resources and improving public health. Since the task force concluded its work, New Hampshire has seen a 33% drop in GHG emissions, a reduction that has exceeded the GHG emissions reduction pathway identified.



1.4 Potential GHG Emissions

1.4.1 Electrification

At present, the transportation and building sectors’ GHG emissions in New Hampshire are flat and even rising slightly. The primary reason for this is that vehicles have seen a limited improvement in fuel efficiency until very recently, and it takes a long time for the New Hampshire fleet of 1.3 million vehicles to be fully replaced. Further, there has been a modest population increase over the past 20 years and this increase offset any reduction in vehicle efficiency that has begun to occur. Similarly, buildings in New Hampshire have improved in electrical efficiency, but thermal efficiency, through weatherization and air sealing, has been more limited. As a result, many homes and businesses are still consuming considerable amounts of oil, propane, natural gas, and kerosene for heating during the extended New Hampshire heating season. While efficiency has increased, this has been offset by the construction of new buildings as the population has increased.

The emergence of new electrified technologies offers the potential to reduce New Hampshire’s GHG emissions. This includes electric vehicles (EVs), which are becoming increasingly available as new companies offer new models each year. These vehicles are increasing in range and charging speed, while also becoming increasingly cost-competitive with traditional internal combustion engine vehicles. Over the full life of the vehicle, EVs are

already less expensive to buy, maintain, and “fuel” than traditional cars and the “total cost of ownership” will only fall as companies ramp up their production and innovation continues.

One of the primary drivers of the cost reduction is the efficiency of electric motors compared to internal combustion engines. These motors can be up to four times as efficient as gas or diesel motors. This not only results in lower energy consumption and lower energy costs associated with EV “fueling,” but it also results in lower associated GHG emissions. These lower emissions occur regardless of the source of energy powering the electric generation facilities.¹⁹

Heat pumps, including air-source and ground-source models, for building space heating and water heating offer similar cost and GHG benefits. While the basic technology behind heat pumps is decades old, providing the commonly understood cooling for refrigerators, freezers and air-conditioning, new heat pumps can achieve efficiencies of 300% or greater. That means that for every unit of electricity consumed, the heat pumps are able to deliver three or more units of useful heating; units capable of working in New Hampshire’s cold/moist climate zones are increasingly available. Due to the high efficiency of the heat pumps, they offer similar potential reductions in overall building energy consumption and energy costs, as well as GHG emissions associated with building energy use regardless of electricity generators power source.

Due to the efficiency of these new technologies that are increasing in availability and performance for both the transportation and building sectors, there is an opportunity to reduce end-use energy consumption, energy costs, and the associated GHG emissions. As these technologies are deployed, they have the potential to amplify the reductions in the New England region if offshore wind power is deployed at scale.

1.4.2 Complementary Role of Wind

While electrification has the potential to reduce GHG emissions due to significant efficiency gains associated with the technology, offshore wind offers the potential to increase those reductions by providing a sizable source of non-emitting power supply to the grid. At present, the largest source of non-emitting power is nuclear power, which currently is baseload generation that runs at full capacity. The vast majority of the remaining generation in New Hampshire and New England is provided by natural gas, with other fossil fuels providing a small share. As more vehicles and buildings convert to electrified technologies, this will put an upward pressure on total electricity generation and demand. Most of this, under the present electric generation fleet in the Northeast, will likely be met by natural gas facilities.

If offshore wind is deployed in the Gulf of Maine, there is an opportunity to increase non-emitting electricity generation for the New England Grid. Due to the interconnection between the states in the ISO-NE region, the emissions associated with New Hampshire’s energy use would fall regardless of where in New England that wind power came ashore.

Any policy or program that New Hampshire establishes to support the development of wind energy production in the region will likely have a net positive impact on New Hampshire and the New England region’s GHG emissions above and beyond any direct economic impact.

¹⁹ EEA (2018). *Electric Vehicles From Life Cycle And Circular Economy Perspectives*, European Environmental Agency, <https://www.eea.europa.eu/publications/electric-vehicles-from-life-cycle>.

Report B – Infrastructure and Supply Chain Opportunities

2 PORT INFRASTRUCTURE

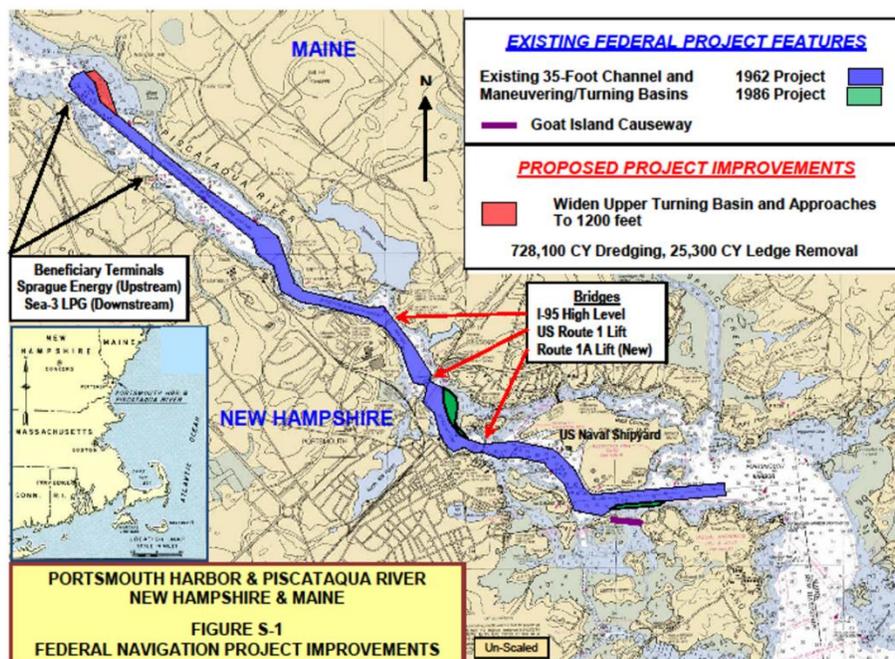
2.1 Current Infrastructure

The Piscataqua River, including Portsmouth Harbor, has a number of Federal Navigation Projects that have been completed, are under construction, or are planned under the control of the U.S. Army Corps of Engineers, New England District. The projects are designed and maintained by the Corps to accommodate ocean-going vessels of 750 feet in length with a draft of 35 feet. There are seven deep draft (35-foot) industrial terminals servicing 16 businesses along the river, not including the Portsmouth Naval Shipyard.

[The Economic Impact of the Piscataqua River and the Ports of Portsmouth and Newington](#) report was sponsored by the Piscataqua River Economic Development Committee to gain a better understanding of the economic impact of maritime commerce in the region of southeast New Hampshire and southwest Maine. The authors of the study are Matt Magnusson (University of New Hampshire), Charles Colgan (University of Southern Maine), and Ross Gittell (University of New Hampshire).

The Army Corps published a Navigation Safety Improvement Study identifying five projects:

- Removal of ledge off Goat Island in New Castle, NH. (Completed)
- Removal of ledge off Badgers Island, ME. (Completed)
- Create a 100-foot radius-turning basin between the Memorial Bridge and the Sarah Mildred Long Bridge, adjacent to the state-owned terminal. (Completed)
- Improve the alignment and expand the horizontal opening of the Sarah Mildred Long Bridge. (Completed)
- Expansion of the uppermost Turning Basin. (Begins November 2021)



Market Street Marine Terminal

The Market Street Marine Terminal is a state-owned facility and is the only public access, general cargo facility on the Piscataqua River.

Features of the Facility

- 6.5 acres of Paved Access Outside Lay Down Area
- 20,000 square feet of Covered Warehouse
- On-site Rail Access
- 600-foot berth, 35-foot/Mean Low Water
- Half a mile proximity to I-95
- Two miles from Pease International Tradeport
- Three nautical miles from Open Sea
- Fresh Water Terminal

Cargo Handling Capabilities

- Bulk Cargo (Aggregate, Salt, Wood Chips)
- Break Bulk (Industrial and Machinery Parts, Construction Materials)
- Project Cargo (Power Plant Components, Vacuum Tanks)
- Container Cargo



Main Wharf Rehabilitation and Modification Project

The Main Wharf at the facility was constructed in two phases:

- 1964 – 300-foot Concrete Pier (South End)
- 1977 – Additional 300-foot Concrete Pier (North End)

A waterfront inspection of the Main Wharf in 2017 indicated that the structure needs rehabilitation. Additionally, the original design of the 1964 wharf left an open water area between the wharf and the shore, connecting the wharf by two access bridges. This open water area has been an obstacle to handling cargo at the south end of the wharf. The proposed project will rehabilitate the existing structure, in-fill the open water area, and bring the wharf to a state of good repair.

Functional Replacement Project

The original Sarah Mildred Long Bridge bisected the Market Street Marine Terminal. Construction of the new Sarah Mildred Long Bridge included the relocation of the bridge to the north, which removed the bridge from the terminal. However, because of the new location and the approach of the rail line, the terminal lost the functional use of the smaller concrete wharf known as the “Barge Dock.” The Barge Dock was specifically designed to accommodate barges and other low freeboard vessels. The 300-foot dock was equipped with a fender system that extended to one foot above mean low water. This fender system prevented low freeboard vessels from drifting under the concrete structure.

The components of the functional replacement are:

- 145-foot extension to the North End of the Main Wharf.
- 60-foot extension to the South End of the Main Wharf.
- Dredging the footprint of Old Sarah Mildred Long Bridge to 35-foot Mean Low Water.
- Low Freeboard Fender System the full length of the Main Wharf, including extensions.
- Alteration of terrain, shore side and footprint of the Old Sarah Mildred Long Bridge.
- Relocation of the Emergency Floating Dock.

Schiller Power Station

GSP Schiller, LLC (GSP), a New Hampshire-based company, is a wholesale energy company that owns and operates Schiller Station and its related terminal facility located along the Piscataqua River. Schiller Station’s two coal-fueled and one biomass steam turbine generating units have supplied power to New Hampshire for generations. Schiller Station encompasses approximately 81 acres and is positioned on the west bank of the Piscataqua River, approximately 5.75 nautical miles from the river’s mouth in Portsmouth. The facility is situated on the deep water shipping channel of the Piscataqua River with on-site railway access and is in close proximity to I-95 and Pease International Tradeport.

The active dock is 407 feet long and 38.5 feet wide and is capable of accommodating Panamax class vessels from approximately 200 feet to 700 feet in length. Dock construction is comprised of a concrete deck and is supported by steel framing and 22 caissons anchored in the bedrock. The dock is equipped with a rail-mounted fully enclosed screw type unloader, used on bulk ships as well as smaller barges.

Portsmouth Naval Shipyard

The Navy's mission statement for the Portsmouth Naval Shipyard:

“Portsmouth Naval Shipyard's primary mission is the safe overhaul, repair and modernization of the U.S. Navy's nuclear-powered attack submarine fleet, specifically Los Angeles and Virginia-class submarines. Portsmouth Naval Shipyard provides quality overhaul work in a safe, timely and affordable manner. This includes a full spectrum of in-house support--from engineering services and production shops, to unique capabilities and facilities, to off-site support--all of which serves the multifaceted assortment of fleet requirements.”

3 COASTAL TRANSMISSION INFRASTRUCTURE

3.1 Background on Issue

As offshore wind leasing has moved forward in the Northeast and Mid-Atlantic regions, so have the conversations about the transmission of that energy from the sea onto land. While much of the focus of siting and evaluation is on the location of the turbines themselves, the transmission of hundreds or thousands of megawatts of electricity has its own challenges. The debate about transmission often centers on whether there should be distributed transmission (for instance, each wind farm has its own wire to the land) versus centralized transmission (for instance, a single or few trunk lines). The economics of this decision are not inconsequential. A study by the Batelle Group found that the cost of transmission could be reduced by \$1.1 billion if accomplished in a planned and coordinated fashion.

The Northeast Regional Ocean Council (NROC) and the Mid-Atlantic Regional Ocean Council (MARCO) organized a transmission webinar series in 2021. The presentations made at those webinars are an excellent resource for anyone interested in more specific information, which can be found in this report: [Offshore Wind Transmission Webinar Series | Northeast Ocean Planning Webpage](#).

The state agencies that drafted this report were fortunate to receive assistance to compile the information below with funding from NROC. John Dalton, President of Power Advisory LLC, is an expert in transmission issues who was asked to compile information about the current state of transmission in the Gulf of Maine, examine the pertinent issues, identify the potential role for New Hampshire, and to note approaches for transmission planning that may be appropriate to the region. The text below is pulled from Mr. Dalton's full report, which is in Appendix D.

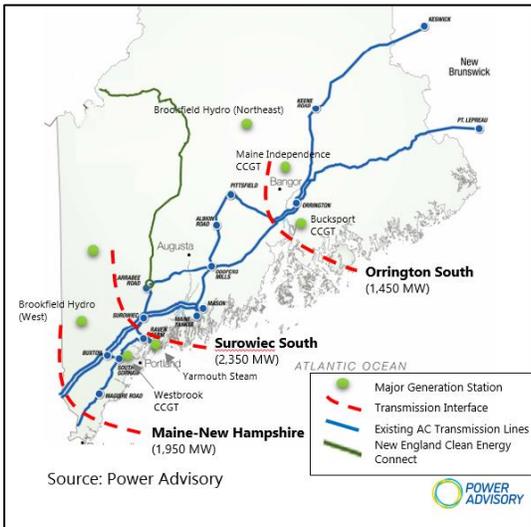
3.2 Gulf of Maine Transmission Issues and Opportunities

The Gulf of Maine offers among the highest wind speeds in the United States. However, many of the suitable sites in the Gulf of Maine are in deep water that will require floating offshore wind technology, which is currently costlier than offshore wind turbines with fixed foundations. The cost of floating offshore wind technology is forecast to decline – in part because floating systems avoid the high installation cost of fixed foundations.

A critical question for the development of offshore wind generation is where it will connect to the onshore transmission grid. Coastal Maine is likely to offer the shortest interconnection distances to the onshore grid. However, Maine is beset with several transmission constraints. For example, Maine is developing a transmission corridor to Quebec that would consume capacity, as would the requirement for procurement of renewables in the short run.

Massachusetts is farther away from the likely locations of Gulf of Maine wind turbines and there are few locations for line landing locations north of Gloucester. One likely location could be the now retired Pilgrim nuclear generating station. However, that is located well south of Boston, which complicates the siting of cables given the very busy nature of the area.

Below are transmission maps for Maine and Massachusetts.



3.3 New Hampshire Transmission Challenges and Onshoring Opportunities

The New Hampshire 2029 Needs Assessment, the most recent ISO-NE transmission study, was released in May 2021. The study focusses on the major transmission facilities within New Hampshire (known as Pool Transmission Facilities (PTF)) and assesses the degree to which they meet various North American Electric Reliability Corporation (NERC), Northeast Power Coordinating Council (NPCC), and ISO-NE planning criteria that are designed to ensure the reliability of electricity supply. For example, the degree to which voltage limits and thermal constraints are violated (for instance, violations) with the loss of transmission lines under various contingencies. This Needs Assessment identified relatively minor transmission upgrades to address these violations. A full copy of the study can be found on the [ISO-NH New Hampshire and Vermont Key Study Area webpage](#).

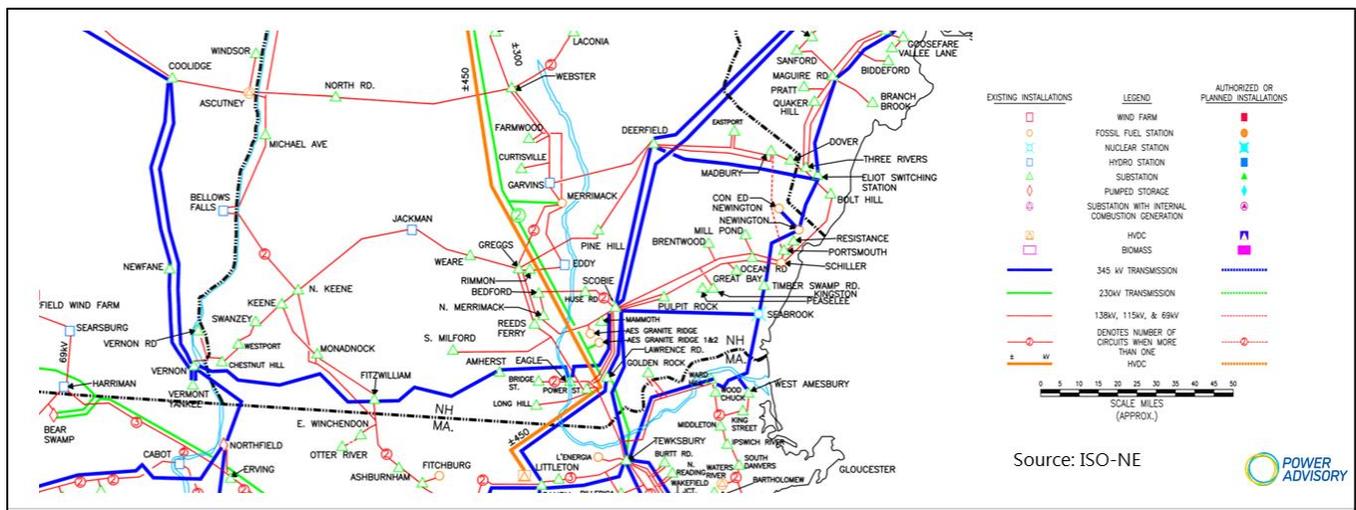
With annual electricity consumption of about 11 million MWh, about 90% of New Hampshire’s electricity requirements can be supplied by the 1,250 MW Seabrook nuclear power plant. With this and the output of various generating units, including two large natural gas-fired combined cycle units (1,200 MW), the 450 MW Merrimack generating station and various renewable power plants, New Hampshire has historically been a net exporter. On average, between one-third and half of the electricity generated in New Hampshire is exported to other states or Canada.

This suggests that the transmission lines that connect New Hampshire to the rest of the ISO-NE grid are likely to be more heavily loaded, leaving less capacity for the export of offshore wind generation. However, the retirement of existing fossil generating units in New Hampshire could reduce the loadings on these transmission lines and create more opportunities for the export of offshore wind generation.

Below is a table based on data from the US Energy Information Administration that demonstrates the level of export.

New Hampshire Electricity 2019 Data (Mwh)				
Total Net Generation	Total Retail Electricity Sales	Estimated Losses	Total Electricity Requirements	Net Interstate Exports
18,026,595	10,711,657	580,828	11,292,485	6,623,325

Given the transmission interconnection issues in Maine, New Hampshire is likely to represent an attractive interconnection point for offshore wind generation from the Gulf of Maine. The 345 kV transmission lines are the superhighways for electricity and are the necessary components of moving vast amounts of offshore wind energy around New England. Southern New Hampshire is fortunate to have a significant amount of that kind of “energy highway” infrastructure. As is evident in the diagram below, virtually all the 345 kV networks in New Hampshire are in the southern part of the state, with a 345 kV network running close to the coast.



Establishing preferred points of interconnection for offshore wind generation typically involves assessing the tradeoffs associated with the length of required transmission cable runs, with shorter cable lengths preferred given lower costs and reduced environmental impacts, versus the relative attractiveness of points of interconnection (POI), which considers the suitability of the POI in terms of the available take away capacity and environmental impacts.

Some of the most attractive POIs are recently retired generating facilities, given that they have available transmission capacity that can be utilized, limiting the need for potentially expensive transmission system upgrades. With these retired or retiring generating facilities typically being fossil generating units in Southern New Hampshire, they are typically located on coastal waterways given requirements for cooling water. These facilities provide ready access for the subsea transmission cables that would deliver the offshore wind generation from the Gulf of Maine.

Given these criteria, there are several possible POIs in Southern New Hampshire including:

1. Schiller Generation Station (150 MW) in Portsmouth on the Piscataqua River, which closed earlier this year.

2. Newington Generation Station (400 MW) in Newington, also on the Piscataqua River, a quarter mile Northwest of Schiller.
3. The Essential Power LLC Newington combined cycle gas turbine facility, a 525 MW natural gas-fired unit also near the Piscataqua River and less than a mile from Newington Station.

In addition, while not nearing retirement age, the Seabrook Nuclear Generating Station in Seabrook is another possible POI. Given its relative size and requirements for redundancy, Seabrook is a major transmission interconnection point. However, the available transmission infrastructure was built to reliably deliver the output of Seabrook to New England load centers. As indicated by the rating of the Seabrook transmission interface, there is relatively little surplus transfer capability for Seabrook. This is not surprising, given that these facilities were built to interconnect Seabrook and the rated capacity of the unit has been increased from 1,150 MW to about 1,250 MW.

Seabrook was originally designed as a two-unit generating station, but the second unit was cancelled after construction was approximately 25% complete. There are three 345 kV transmission lines that connect Seabrook to the rest of the ISO-NE transmission grid. With all three 345 kV transmission lines in service, there is additional available interconnection capacity at Seabrook. However, transmission planning considers the loss of one of these 345 kV lines as an N-1 contingency and under such conditions, there is little to no available additional transfer capability at Seabrook. In addition, the Nuclear Regulatory Commission has standards for the interconnection of nuclear generating stations that would need to be considered. Therefore, more analysis is needed to determine actual capacity.

Interconnecting offshore wind generation from the Gulf of Maine is likely to affect New Hampshire in several different ways.

First, the delivery of large volumes of offshore wind from the Gulf of Maine in New Hampshire should reduce the risk of increases in energy prices from transmission congestion:

- The electric energy market administered by ISO-NE has locational marginal prices (LMPs), where energy prices can vary across the grid when there are transmission constraints or differences in marginal losses.
- The injection of significant volumes of offshore wind generation from the Gulf of Maine will reduce the risk of transmission congestion in New Hampshire that can lead to higher prices during high load periods and can increase the likelihood of lower LMPs when offshore wind output is high.

Second, interconnecting offshore wind will require upgrades to the existing transmission infrastructure. The magnitude of the required investment depends on the interconnection point as well as the interconnection capacity.

Finally, to date, locales that have accepted cable landfall infrastructure for offshore wind have negotiated significant Community Benefit Agreements with the project developers.

3.4 Regional Transmission Issues and Opportunities

Pursuant to a 2019 request by New England State Committee on Electricity (NESCOE), ISO-NE conducted a [study on the impacts of the transmission system and wholesale electricity markets](#) of up to 8,000 MW of offshore wind by 2030, including the 1,000 MW already under-contract at that time.

For this study, ISO-NE developed future interconnection scenarios for offshore wind based on interconnection points identified by offshore wind developers as reflected by interconnection queue requests. Based on the results of several of these interconnection studies, ISO-NE identified the approximate megawatt quantities that could interconnect without major transmission upgrades. Because this study focused on POIs where there already interconnection queue requests for offshore wind farms proposed in the Massachusetts Wind Energy Area south of Nantucket and Martha's Vineyard, this study did not include POIs for offshore wind developed in the Gulf of Maine.

NESCOE or New Hampshire, Maine and Massachusetts could request that ISO-NE conduct such a study for POIs that are more appropriate for offshore wind from the Gulf of Maine.

There is a lot at stake from an economic standpoint. Onshore transmission facilities will need to be modified with a corresponding investment. This investment for offshore wind interconnection is likely to result in-state employment and economic development benefits. Economic multipliers and the magnitude of these investments vary. For example, \$20 million invested in interconnecting offshore generation to the onshore grid in New Hampshire could result in approximately \$87 million in GDP and 600 construction-period jobs.

For the region to capture the benefits of centralized onshore locations, planning will be necessary. There are several existing models for transmission development. Some of these include the Generator lead line/Radial approach, Coordinated Approach and the current New Jersey Approach.

Generator Lead Line/Radial Approach

- Absent policy intervention, offshore wind interconnection facilities would likely be funded by the owner of the offshore wind generation that requires these interconnection facilities. This traditional model is employed to develop and fund interconnection facilities. Under this approach, the generation project developer identifies a preferred location for interconnecting the project to the onshore grid and accepts responsibility for the cost of these facilities.
- This model is relatively straightforward and is favored by some because of the strong incentives that it provides to minimize these interconnection costs in the short-term, as well as simplifying the direct comparison of offshore wind projects when their interconnection costs are included as part of the total project cost and required project pricing.
- One disadvantage of this approach is that it does not necessarily result in the most efficient, cost-effective utilization of the available existing transmission infrastructure when high levels of offshore wind deployment are anticipated in the long-term. For example, if the lowest cost interconnection alternative has the capacity to interconnect 1,100 MW but the project proposing to use this interconnection point is only 800 MW, it is conceivable that there will be 300 MW of low-cost interconnection capability that is effectively stranded.

Coordinated Approaches

- An alternative approach that better addresses this issue is coordinated transmission development to support the interconnection of the amount of offshore wind that is anticipated to be developed.
- Coordinated approaches seek to minimize the total interconnection costs of all offshore wind projects and can also reduce the environmental impacts associated with the landing of this offshore wind generation. A clear challenge of such an approach is realizing sufficient cost savings to compensate for anticipated risks of potentially pre-building interconnection facilities. To produce such savings generally requires that there be a sufficiently large volume of offshore wind developed so the required interconnection facilities can realize economies of scale or ensure that the lowest cost interconnection facilities are fully utilized. With state offshore wind targets often increased incrementally, this can result in a piecemeal development of the required transmission infrastructure. Another complicating factor is other than large states with sizable electricity demand (e.g., New York with a 9,000 MW offshore wind target), the savings from coordinated transmission development can require that nearby states work together to plan these interconnection facilities. This requires agreements to share the cost of these facilities and a full understanding of the future offshore wind procurement goals of a state.
- Offshore wind developers generally prefer the generator lead line approach given that it best allows them to manage the risks of interconnecting their project to the onshore grid, which is obviously critical to successful project development. However, as noted above, because the lowest cost POIs requiring the least complex onshore upgrades are often utilized by the initial projects, developers of later projects will face substantially greater challenges.

New Jersey Competition Approach

- New Jersey has requested that the regional transmission organization that manages and plans the transmission grid in which it participates, PJM Interconnection (PJM), use a framework that PJM developed to consider state public policy objectives in its transmission planning process. Specifically, New Jersey requested that PJM evaluate competing proposals that would enable the interconnection of the state's 7,500 MW offshore wind goal.
- Proposals are due in the middle of August and PJM is scheduled to make preliminary recommendations to New Jersey in 2021, with final recommendations in 2022. New Jersey ratepayers will have cost responsibility for any transmission solutions that it selects. However, it could determine that none of these proposals are in the customers' interests.
- New Jersey's experience warrants following. As discussed, the relative attractiveness of such solutions is strongly influenced by the volume of offshore wind to be developed, such that what is practical for New Jersey may not be for New Hampshire.

3.5 Future Needs

This report provides a high-level assessment of potential transmission issues posed by the interconnection of offshore wind generation from the Gulf of Maine to New Hampshire. The need for and importance of additional analysis of these issues will depend in large part on the underlying level of offshore wind development in the Gulf of Maine.

As discussed above, the need for coordinated transmission development depends in large part on the magnitude of offshore wind ambitions as well as the severity of the underlying transmission constraints.

Alternatively, transmission development can occur under the generator tie-line model discussed above where individual offshore wind developers identify preferred transmission interconnection points. This is how transmission development for offshore wind has occurred so far in New England. There have been various ISO-NE and other studies that evaluated higher levels of offshore wind development, but these have not resulted in the development of transmission facilities to support this development.

This initial analysis suggests that the New Hampshire transmission network has the ability to connect relatively modest amounts of offshore wind generation. However, should New Hampshire seek to connect large volumes of offshore wind (for example, significantly greater than 1,000 MW) then further analysis of interconnection options for the Gulf of Maine offshore wind would be appropriate. This could occur along the lines of the NESCOE request to ISO-NE for a study of interconnection capability focused on the Gulf of Maine.

4 OFFSHORE WIND SUPPLY CHAIN

4.1 Supply Chain Opportunities

Using the states currently engaged in the federal offshore wind permitting and leasing process as a guide, industry has developed projections for the supply chain opportunities these projects will create.

The two charts below are based on projections from the Special Initiative on Offshore Wind's October 2021 white paper ([Supply Chain Contracting Forecast for U.S. Offshore Wind Power Report](#)).

Forecasts of State Offshore Wind Power Procurements Through 2030	
New Jersey	7,558 MW
New York	9,314 MW
Massachusetts	5,604 MW
Connecticut	2,108 MW
Rhode Island	1,000 MW
Maryland	1,568 MW
Virginia	5,200 MW
Total by 2030	32,352 MW

Components Necessary to Achieve the Projected Build-Out of Domestic OSW Power Capacity	
More than 2,057 offshore wind turbines and towers	\$43.9 billion
More than 2,110 offshore turbine and substation foundations	\$17.0 billion
More than 8,000 kilometers of upland, export and array cables	\$12.9 billion
More than 53 onshore and offshore substations	\$10.3 billion
Other Capital Expenditures	\$16.0 billion
Development Expenditures	\$6.16 billion
Operational Expenditures	\$2.83 billion
Total by 2030	\$109.09 billion

New Hampshire Offshore Wind Business Supply Chain Registry

The development of robust supply chain networks needed to provide equipment and personnel to developers, suppliers and manufactures is critical to taking advantage of the supply chain opportunities created by the deployment of offshore wind projects. Accordingly, New Hampshire needs to provide tools to connect the offshore wind industry and other key stakeholders to those businesses and workforces with the skills and interest to participate in the offshore wind industry.

To that end, BEA has created the New Hampshire Offshore Wind Business Supply Chain Registry. This registry provides the opportunity for businesses to voluntarily add their company name to the list of businesses interested in participating in offshore wind construction projects and supply chain operations, which will in turn be provided to interested developers, manufacturers, and other stakeholders if the deployment of offshore wind in the Gulf of Maine is ever realized.

Information about the registry and other information about offshore wind in the Gulf of Maine can be found on the [BEA Offshore Wind webpage](#).

APPENDIX A – EXECUTIVE ORDERS



STATE OF NEW HAMPSHIRE
OFFICE OF THE GOVERNOR

CHRISTOPHER T. SUNUNU
Governor

STATE OF NEW HAMPSHIRE
BY IDS EXCELLENCY
CHRISTOPHER T. SUNUNU, GOVERNOR

Executive Order 2019-06

An order preparing New Hampshire for future offshore wind development and the Bureau of Ocean Energy Management (BOEM) Offshore Renewable Energy Task Force

WHEREAS, the Federal Bureau of Ocean Energy Management (BOEM) has accepted New Hampshire's request for an offshore renewable energy task force for the Gulf of Maine, in regional partnership with Massachusetts and Maine; and

WHEREAS, New Hampshire values clean air and recognizes that emissions reductions can improve the quality of life for all New Hampshire residents; and

WHEREAS, New Hampshire has an unprecedented opportunity as offshore wind in the Gulf of Maine is an abundant source of renewable energy that can be generated at scale; and

WHEREAS, New Hampshire is uniquely situated to benefit from this new industry in ways that will attract investment, boost the state's economy, and create good paying jobs; and

WHEREAS, New Hampshire is committed to working with stakeholders to ensure the impacts of this new industry do not unduly burden existing offshore uses such as commercial fishing and maritime interests.

NOW THEREFORE, I, CHRISTOPHER T. SUNUNU, GOVERNOR OF THE STATE OF NEW HAMPSHIRE, by the authority vested in me pursuant to part II, article 41 of the New Hampshire Constitution, do hereby order, effective immediately, that:

I. In the interest of enhanced agency collaboration and public participation throughout the BOEM Task Force process, and to prepare New Hampshire to maximize the opportunity presented by this new industry, the following advisory boards to the BOEM Task Force are hereby established:

- a. Fisheries, endangered species, and environmental impacts advisory board, chaired by the commissioner of the Department of Environmental Services, or designee.
- b. Workforce, economic development, and supply chain advisory board, chaired by the commissioner of the Department of Business and Economic Affairs, or designee.
- c. Existing offshore industries advisory board, chaired by the executive director of the Pease Development Authority, or designee.

- d. Siting, transmission, and infrastructure advisory board, chaired by the director of the office of strategic initiatives, or designee.
2. Each Advisory board shall include five members, representing relevant stakeholders, appointed by the chairperson. Advisory boards may establish working groups to further facilitate discussion.
 3. Advisory board meetings shall be open to the public. Each advisory board shall report updates to the New Hampshire members of the BOEM Task Force quarterly, and in advance of a formal BOEM Task Force meeting.
 4. The following studies shall be completed no later than January 2021, and shall be submitted to the Governor, Speaker of the House, Senate President, Public Utilities Commission and the chairs of the relevant committees of the General Court. The Office of Strategic Initiatives (OSI), the Department of Environmental Services (DES), and the Department of Business and Economic Affairs (BEA) shall jointly study and report on:
 - a. The historical and forward looking greenhouse gas reduction potential of offshore wind in the Gulf of Maine at varying levels of system installations.
 - b. New Hampshire's existing port infrastructure, coastal transmission infrastructure, and opportunities for New Hampshire to attract offshore wind supply chain operations to New Hampshire.

Given under my hand and seal at the Executive Chambers in Concord, this 3rd day of December, in the year of Our Lord, two thousand and nineteen, and the independence of the United States of America, two hundred and forty-three.



GOVERNOR OF NEW HAMPSHIRE



**STATE OF NEW HAMPSHIRE
OFFICE OF THE GOVERNOR**

CHRISTOPHER T. SUNUNU
Governor

**STATE OF NEW HAMPSHIRE
BY IDS EXCELLENCY
CHRISTOPHER T. SUNUNU, GOVERNOR**

Executive Order 2021-03

An order amending and restating Executive Order 2019-06 (An order preparing New Hampshire for future offshore wind development and the Bureau of Ocean Energy Management (BOEM) Offshore Renewable Energy Task Force)

WHEREAS, the Federal Bureau of Ocean Energy Management (BOEM) has accepted New Hampshire's request for an offshore renewable energy task force for the Gulf of Maine, in regional partnership with Massachusetts and Maine; and

WHEREAS, New Hampshire values clean air and recognizes that emissions reductions can improve the quality of life for all New Hampshire residents; and

WHEREAS, New Hampshire has an unprecedented opportunity as offshore wind in the Gulf of Maine is an abundant source of renewable energy that can be generated at scale; and

WHEREAS, New Hampshire is uniquely situated to benefit from this new industry in ways that will attract investment, boost the state's economy, and create good paying jobs; and

WHEREAS, New Hampshire is committed to working with stakeholders to ensure the impacts of this new industry do not unduly burden existing offshore uses such as commercial fishing and maritime interests; and

WHEREAS, on December 3, 2019, the Governor issued Executive Order 2019-06, an order preparing New Hampshire for future offshore wind development and the Bureau of Ocean Energy Management (BOEM) Offshore Renewable Energy Task Force; and

WHEREAS, Executive Order 2019-06 created four advisory boards chaired by State agency department heads and required the Office of Strategic Initiatives (OSI), the Department of Environmental Services (DES), and the Department of Business and Economic Affairs (BEA) to issue a report on the greenhouse gas reduction potential of offshore wind and the status of New Hampshire's existing port and coastal transmission infrastructure and opportunities for New Hampshire to attract offshore wind supply chain operations to New Hampshire; and

WHEREAS, during the 2020 session, the Legislature passed and the Governor signed House Bi111245, which established a Commission on Offshore Wind and Port Development that is tasked with many of the same items as those which were assigned to the four advisory boards created by Executive Order 2019-06; and

WHEREAS, the challenges associated with responding to the COVID-19 pandemic have resulted in a need for an extension of the deadline for OSI, DES and BEA to complete the four reports required by Executive Order 2019-06.

NOW THEREFORE, I, CHRISTOPHER T. SUNUNU, GOVERNOR OF THE STATE OF NEW HAMPSHIRE, by the authority vested in me pursuant to part II, article 41 of the New Hampshire Constitution, do hereby order, effective immediately, that Executive Order 2019-06 is amended and restated to read as follows:

1. The following studies shall be completed no later than October 31, 2021, and shall be submitted to the Governor, Speaker of the House, Senate President, Public Utilities Commission and the chairs of the relevant committees of the General Court. The Office of Strategic Initiatives (OSI), the Department of Environmental Services (DES), and the Department of Business and Economic Affairs (BEA) shall jointly study and report on:

- a. The historical and forward looking greenhouse gas reduction potential of offshore wind in the Gulf of Maine at varying levels of system installations.
- b. New Hampshire's existing port infrastructure, coastal transmission infrastructure, and opportunities for New Hampshire to attract offshore wind supply chain operations to New Hampshire.

Given under my hand and seal at the Executive Chambers in Concord, this 1st day of March, in the year of Our Lord, two thousand and twenty- one, and the independence of the United States of America, two hundred and forty-five.

A handwritten signature in blue ink that reads "Christopher T. Sununu". The signature is written in a cursive style and is positioned above the printed name of the Governor.

GOVERNOR OF NEW HAMPSHIRE

APPENDIX B – COASTAL OFFSHORE WIND AREA MAPS

BUSINESS NETWORK FOR OFFSHORE WIND
US OFFSHORE WIND ENERGY AREAS

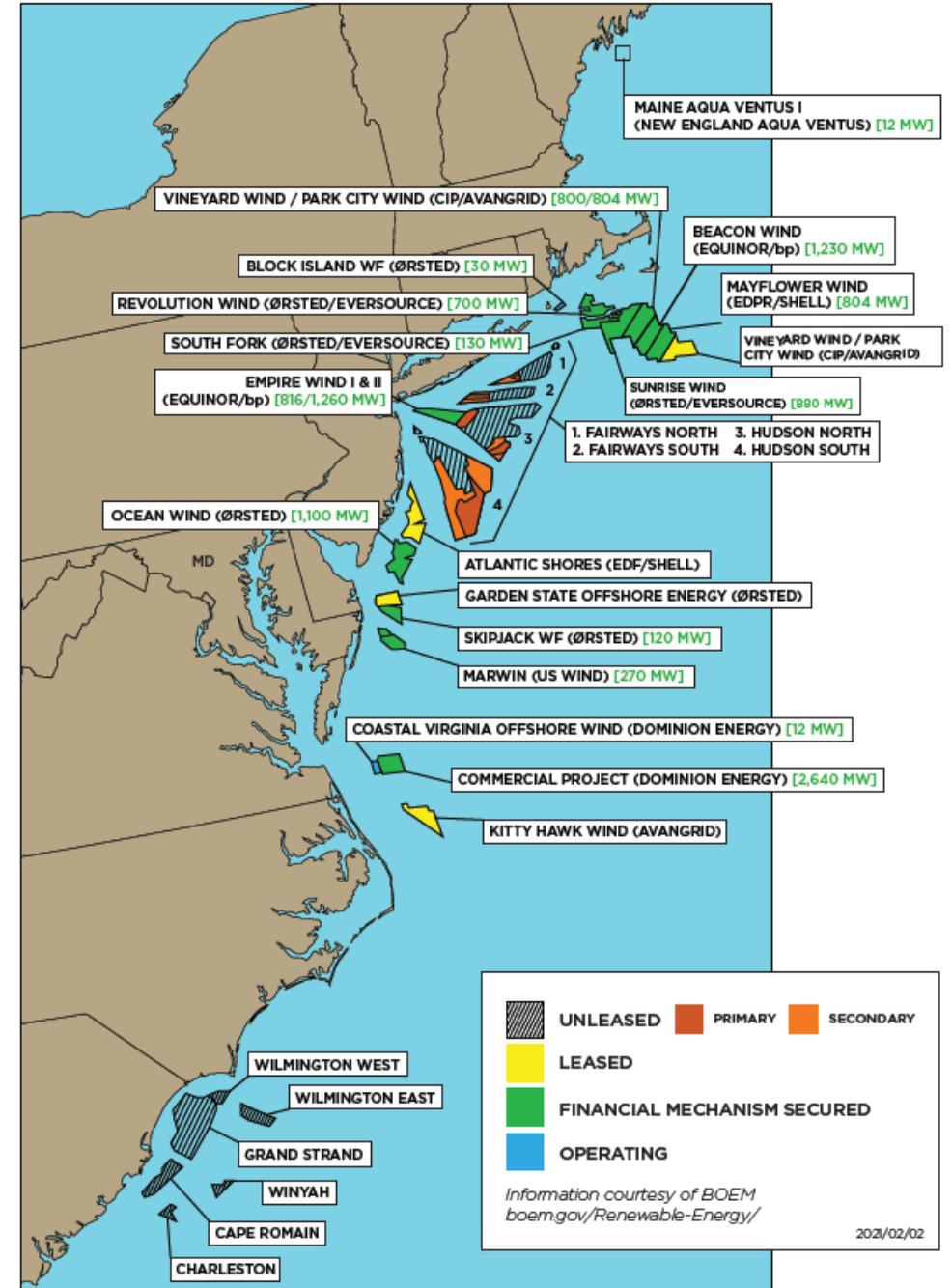
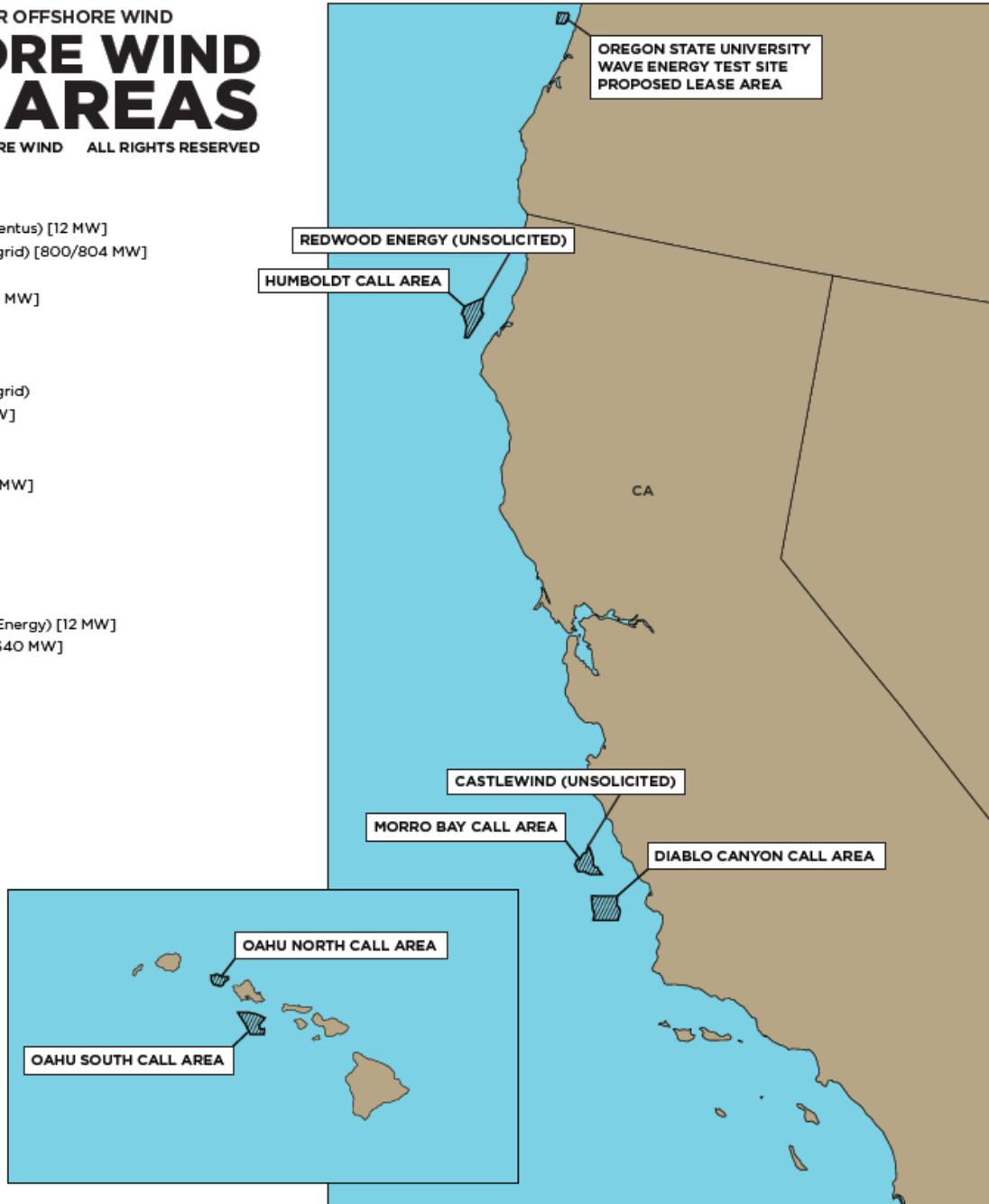
© 2021 BUSINESS NETWORK FOR OFFSHORE WIND ALL RIGHTS RESERVED

EAST COAST

- Maine Aqua Ventus I (New England Aqua Ventus) [12 MW]
- Vineyard Wind / Park City Wind (CIP/Avangrid) [800/804 MW]
- Block Island Wind Farm (Ørsted) [30 MW]
- Revolution Wind (Ørsted/Eversource) [700 MW]
- South Fork (Ørsted/Eversource) [130 MW]
- Beacon Wind (Equinor/bp) [1,230 MW]
- Mayflower Wind (EDPR/Shell) [804 MW]
- Vineyard Wind / Park City Wind (CIP/Avangrid)
- Sunrise Wind (Ørsted/Eversource) [880 MW]
- Fairways North / South
- Hudson North / South
- Empire Wind I & II (Equinor/bp) [816/1,260 MW]
- Atlantic Shores (EDF/Shell)
- Ocean Wind (Ørsted) [1,100 MW]
- Garden State Offshore Energy (Ørsted)
- Skipjack Wind Farm (Ørsted) [120 MW]
- MarWin (US Wind) [270 MW]
- Coastal Virginia Offshore Wind (Dominion Energy) [12 MW]
- Commercial Project (Dominion Energy) [2,640 MW]
- Kitty Hawk Wind (Avangrid)
- Wilmington West Call Area
- Wilmington East Call Area
- Grand Strand Call Area
- Winyah Call Area
- Cape Romain Call Area
- Charleston Call Area

WEST COAST

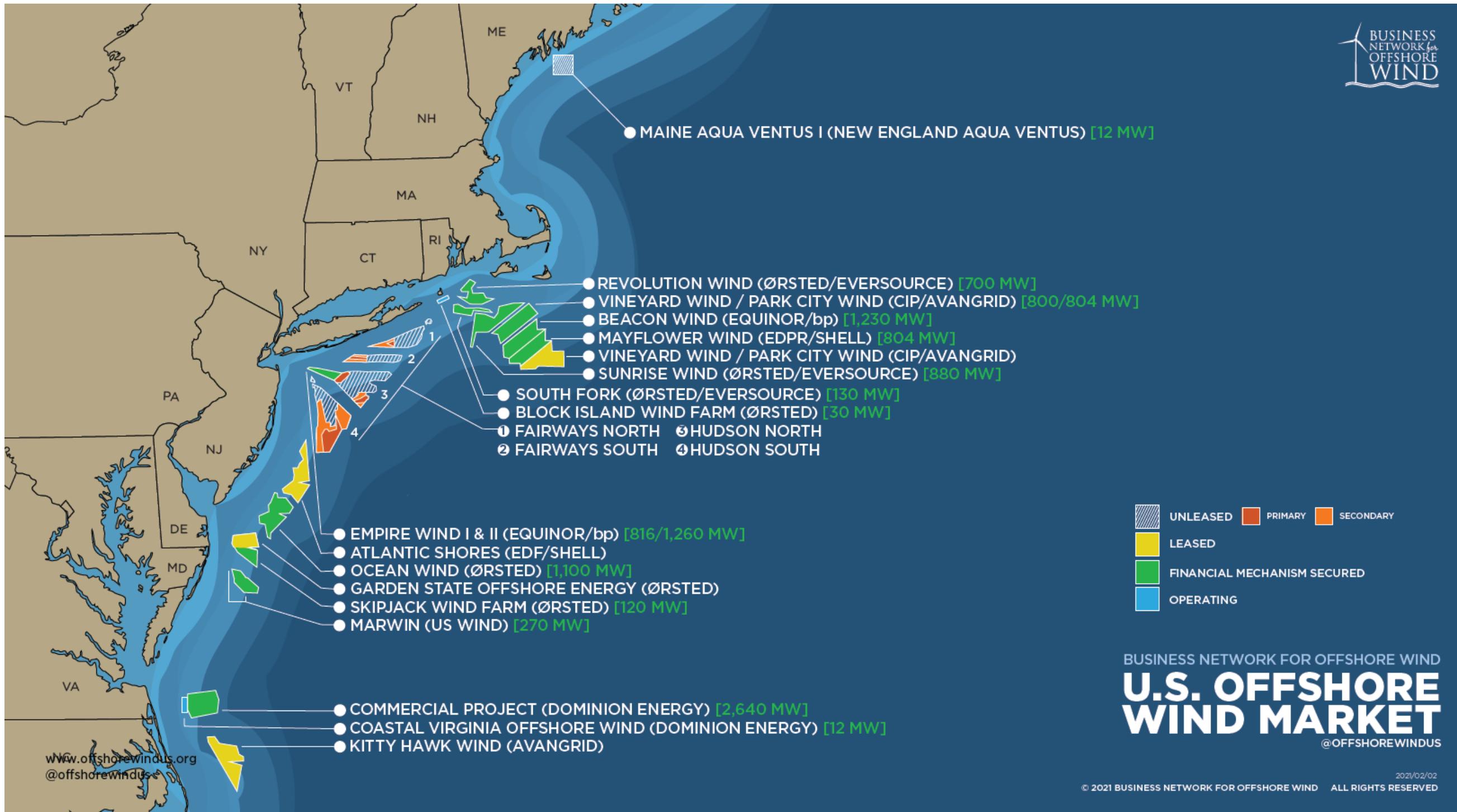
- Oregon State University Wave Energy Test Site Proposed Lease Area
- Redwood Energy (Unsolicited)
- Humboldt Call Area
- Castlewind (Unsolicited)
- Morro Bay Call Area
- Diablo Canyon Call Area
- Oahu North Call Area
- Oahu South Call Area



	UNLEASED		PRIMARY		SECONDARY
	LEASED				
	FINANCIAL MECHANISM SECURED				
	OPERATING				

Information courtesy of BOEM
boem.gov/Renewable-Energy/

2021/02/02



www.offshorewind.us.org
@offshorewindus

BUSINESS NETWORK FOR OFFSHORE WIND
U.S. OFFSHORE WIND MARKET
@OFFSHOREWINDUS



- 1 COEYMANS (Manufacturing)
- 2 PORT OF PROVIDENCE (Construction, Manufacturing)
- 3 BRAYTON POINT (Staging)
- 4 NEW BEDFORD (Staging)
- 5 QUONSET POINT (Construction)
- 6 NEW LONDON STATE PIER (Staging/Pre-Assembly Construction/Installation)
- 7 BRIDGEPORT (Fabrication, Staging, O&M)
- 8 PORT JEFFERSON (O&M)
- 9 SOUTH BROOKLYN MARINE TERMINAL (O&M)
- 10 HOMEPORT PIER (Staging)
- 11 PAULSBORO (Manufacturing)
- 12 ATLANTIC CITY (O&M)
- 13 NEW JERSEY WIND PORT (Staging & Manufacturing)
- 14 TRADEPOINT ATLANTIC (Staging & Manufacturing)
- 15 HAMPTON ROADS (Manufacturing)
- 16 PORTSMOUTH (Staging)
- 17 CHARLESTON, SC (Cables)
- 18 TISBURY (O&M)
- 19 PORT OF ALBANY (Manufacturing)

● OSW ACTIVITY DECIDED
○ UNDER CONSIDERATION
○ OSW LEASE AREAS

BUSINESS NETWORK FOR OFFSHORE WIND

EAST COAST US OFFSHORE WIND PORTS

© 2021 BUSINESS NETWORK FOR OFFSHORE WIND ALL RIGHTS RESERVED

@OFFSHOREWINDUS
 OFFSHOREWINDUS

**APPENDIX C – POWER ADVISORY REPORT: NEW HAMPSHIRE TRANSMISSION AND
IMPLICATIONS OF OFFSHORE WIND IN THE GULF OF MAINE**



New Hampshire Transmission & Implications of Offshore Wind in the Gulf of Maine

New Hampshire Department of
Environmental Services

July 1, 2021

Contents

Prepared by:

John Dalton, President

978-831-3368

jdalton@poweradvisoryllc.com

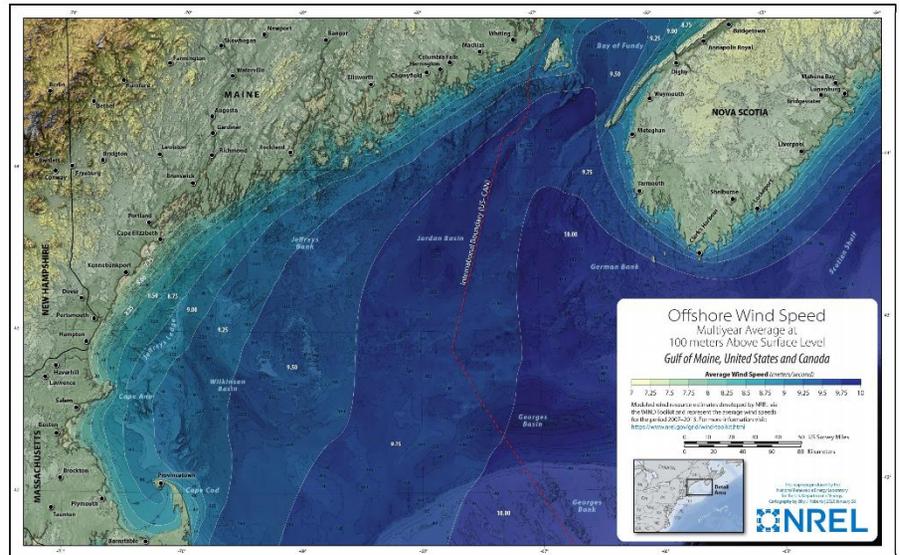
Introduction	3
1. NH Transmission Infrastructure Overview	7
2. Interconnecting OSW Generation in NH	19
3. Models for Transmission Development	29

New Hampshire and Offshore Wind (OSW)

- In December 2019 the Federal Bureau of Ocean Energy Management (BOEM) held its first meeting of the Intergovernmental Renewable Energy Task Force for the Gulf of Maine (BOEM Task Force). Just prior to this meeting Governor Sununu issued an Executive Order that established four advisory boards to the BOEM Task Force to prepare New Hampshire to maximize the opportunity posed by the emerging offshore wind industry. One of the advisory boards was focused on siting, transmission and infrastructure.
- In 2020 the New Hampshire legislature passed and the governor signed legislation that established the Commission on Offshore Wind and Port Development, which was tasked with many of the same items assigned to the previously established four advisory boards. The COVID-19 pandemic resulted in a need to extend the deadline for the four reports that were to be issued by these advisory boards. One element of these reports is coastal transmission infrastructure.
- On March 1, 2021, Governor Sununu issued an updated Executive Order requiring various New Hampshire state agencies to complete two reports, one of which included a review of NH's existing "coastal transmission infrastructure"; this presentation is meant to inform the development of this aspect of the report.
 - o This presentation is a high-level overview of these issues and is not meant to be an in depth analysis of offshore wind transmission alternatives.

OSW in Gulf of Maine

- The Gulf of Maine offers among the highest wind speeds in the United States. However, many of the suitable sites in the Gulf of Maine are in deep water that will require floating offshore wind technology, which is currently more costly than offshore wind turbines with fixed foundations. The cost of floating offshore wind technology is forecast to decline – in part because floating systems avoid the high installation cost of fixed foundations. The OSW potential in the Gulf of Maine is significant.
- The recently issued 2050 Massachusetts Decarbonization Roadmap projects that over 30,000 MW OSW could be developed in ISO-NE.
- Therefore, it is expected that there is a meaningful opportunity for OSW from the Gulf of Maine to play a significant role in meeting the region's clean energy needs.



Source: Bureau of Ocean Management (BOEM) and NREL

Connecting Gulf of Maine OSW to Onshore Grid

- A critical question for the development of offshore wind generation is where will it connect to the onshore transmission grid. Maine is likely to offer the shortest interconnection distances to the onshore grid. However, Maine is beset with a number of transmission constraints.
 - As shown in the figure to the right, there are three major transmission interfaces in Maine: Orrington South, Surowiec South and Maine/New Hampshire. These Maine transmission constraints are shown on the following graphic. The ratings for the transmission interfaces are estimates and vary based on operating conditions.
 - These Maine transmission constraints have limited the onshore wind development in Maine and can be expected to do the same for offshore wind.
- Complicating interconnection in Maine is the development of New England Clean Energy Connect transmission project, a 1,200 MW high

voltage direct current (HVDC) interconnection between Lewiston, Maine and Quebec that is anticipated to deliver about 9.5 Million MWh of energy per year to the southern terminus in Lewiston, Maine. In addition, Maine has mandated the procurement of renewables equivalent to 14% of Maine's 2018 statewide electric load or about 1,500 GWh over the next few years. This volume of energy delivered is likely to add to transmission congestion in Maine and make Maine less attractive as an offshore wind interconnection point.

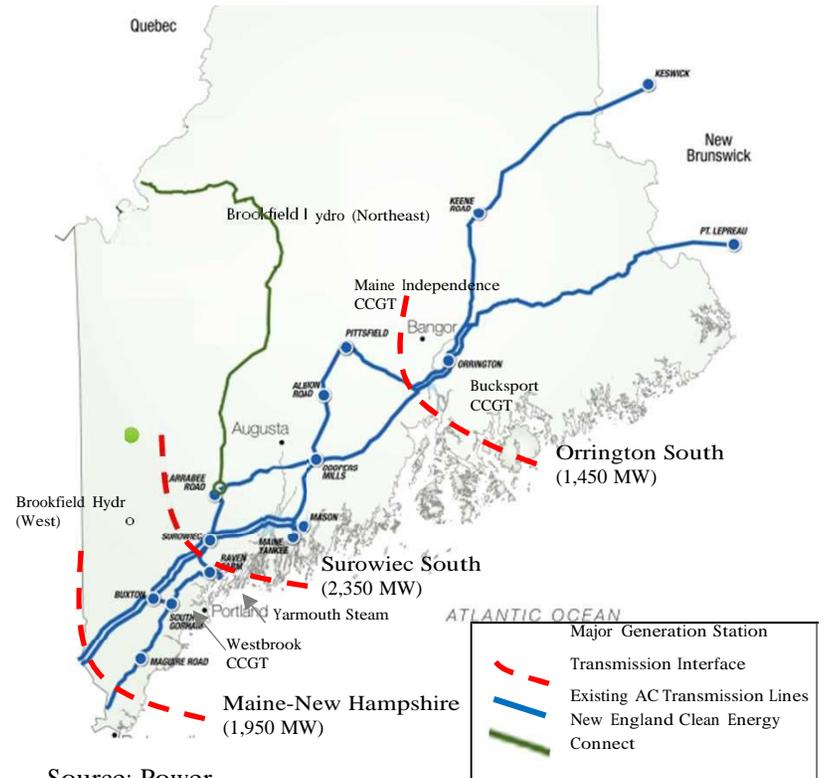


Source: Power Advisory



Connecting Gulf of Maine OSW to Onshore Grid Cont.

- As part of the development of the New England Clean Energy Connect, Avangrid/Central Maine Power is reinforcing Maine's AC transmission system, which will have the effect of increasing the transfer capabilities of the Surowiec South transmission interface by about 1,000 MW.
- These AC facilities include:
 - o A new 27 mile 345 kV transmission line from Coopers Mills substation in Windsor, Maine.
 - o Maine to Maine Yankee substation in Wiscasset, Maine.
 - o A new 0.3-mile 345 kV AC Transmission Line from the existing Surowiec substation in Pownal, Maine to a new substation on Fickett Road in Pownal, Maine.
 - o The rebuilding of various 115 kV transmission lines connecting the Crowley's and Larabee substations to the Surowiec substation.



Source: Power Advisory



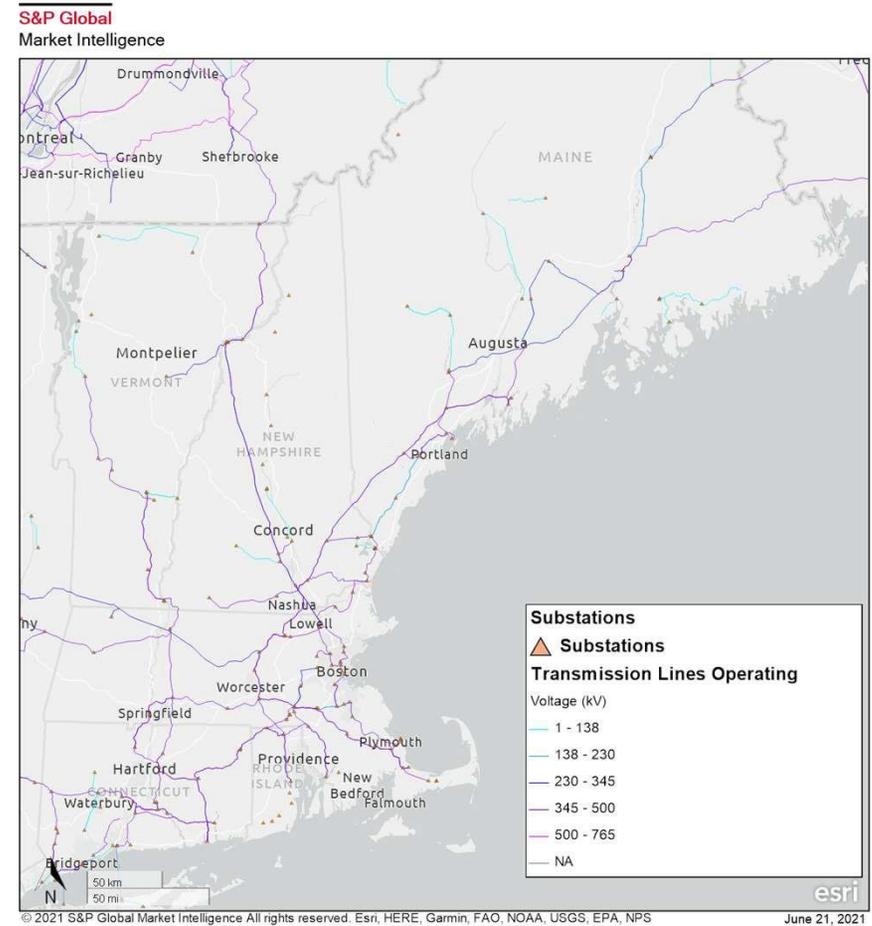
1. New Hampshire Transmission Infrastructure Overview

New Hampshire part of broader New England electricity grid

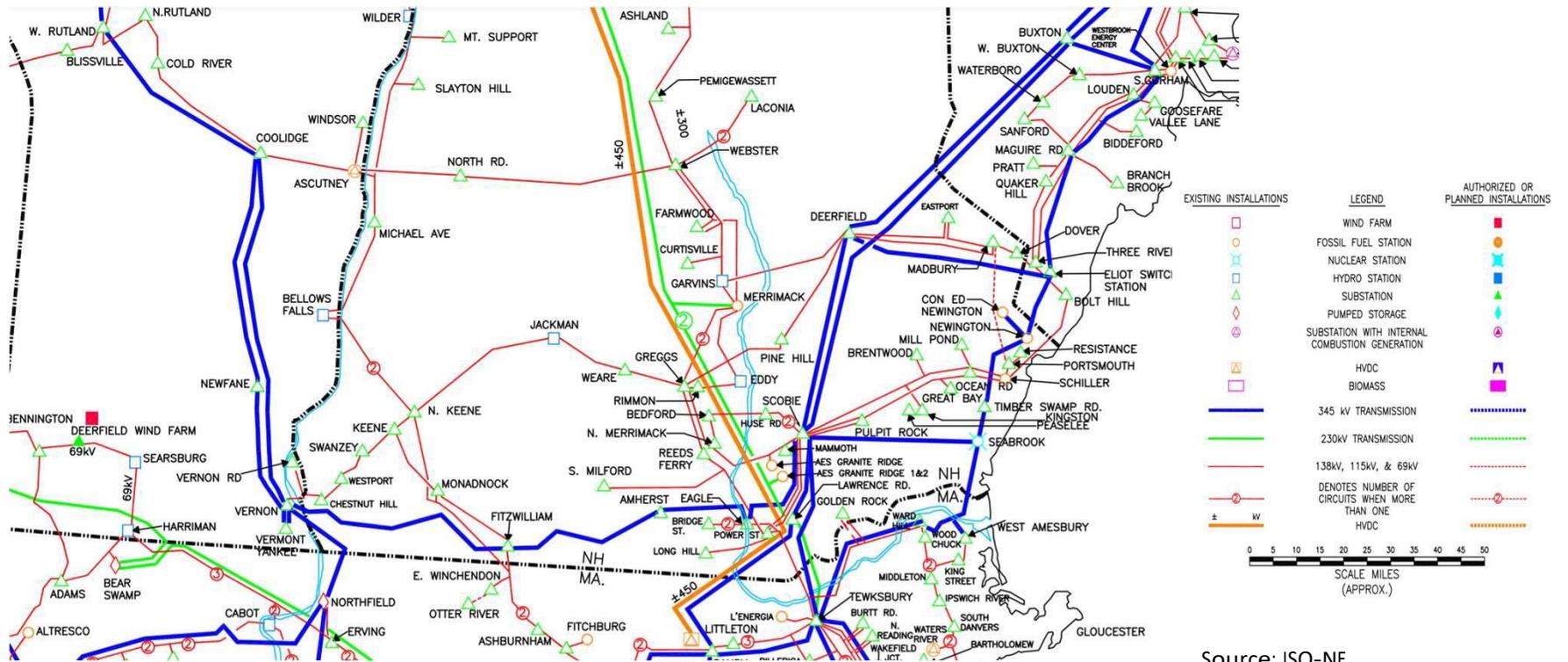
- Given these transmission interconnection issues in Maine, New Hampshire is likely to represent an attractive interconnection point for offshore wind generation from the Gulf of Maine. This report identifies issues, questions, need for technical analysis and opportunities associated with interconnecting offshore wind from the Gulf of Maine in New Hampshire.
- The next slide reviews the major transmission facilities in New England.
- The slide on the subsequent page reviews New Hampshire's transmission infrastructure. As is evident, virtually all of the 345 kV network in New Hampshire is in Southern New Hampshire, with a 345 kV network that runs close to the coast.

ISO-NE Transmission Grid

- The regional electric grid is a network of transmission lines and equipment (e.g., substations that contain transformers and other equipment) operating at voltage levels of 345 kV, 230 kV, 115 kV and 69 kV, which supply substations that ultimately supply customer load.
- As the highest voltage transmission facilities in New England, the 345 kV transmission network represents the bulk transmission system used for transmitting larger volumes of power throughout the region.
- 345 kV transmissions lines are the best candidates for interconnecting offshore wind generation given their greater transfer capabilities.
- As shown, Massachusetts also offers some points of interconnection. These will be reviewed at a high level at the end of this section.



New Hampshire Transmission Infrastructure

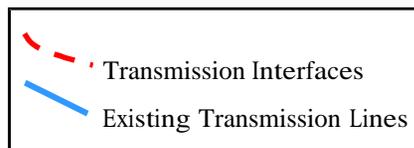


Source: ISO-NE

Required Transmission Upgrades in New Hampshire

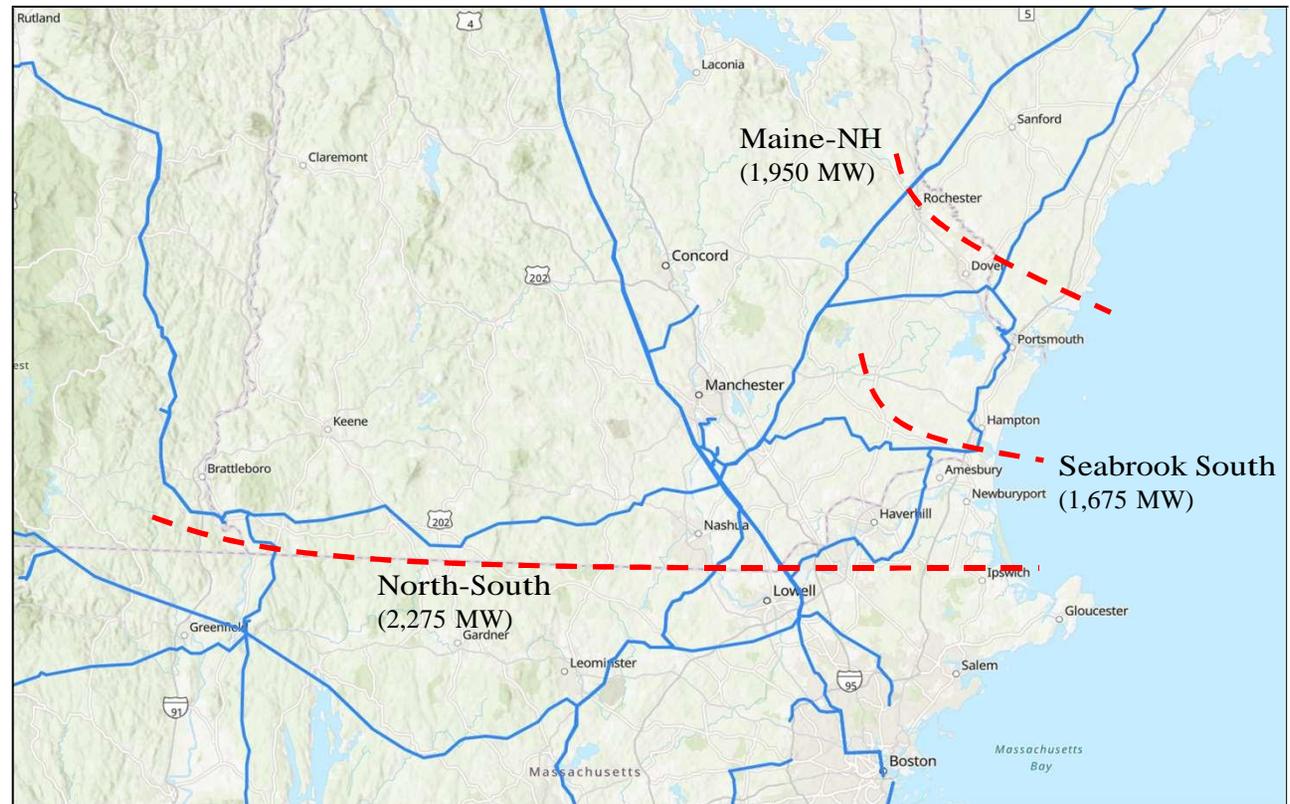
- The most recent ISO-NE transmission study focusing on New Hampshire was the New Hampshire 2029 Needs Assessment, which was recently released (May 2021). The study focusses on the major transmission facilities within New Hampshire (known as Pool Transmission Facilities (PTF) and assesses the degree to which they meet various North American Electric Reliability Corporation (NERC), Northeast Power Coordinating Council (NPCC) and ISO-NE planning criteria that are designed to ensure the reliability of electricity supply. For example, the degree to which voltage limits and thermal constraints are violated (i.e., violations) with the loss of transmission lines under various contingencies.
- This Needs Assessment identified relatively minor transmission upgrades to address these violations.

New Hampshire Transmission Interfaces



- Transmission planners use “interfaces” to characterize transmission constraints and simplify the representation of transmission constraints, which are dynamic and vary with system operating conditions. Therefore, the “ratings” and definitions of transmission interfaces can vary.

Source: Power Advisory



Alternative view of NH Transmission Constraints

Group Transmission Limits			
	Path	A to B (MW)	B to A (MW)
NE East-West	Massachusetts Central – Massachusetts West		
	New Hampshire - Vermont	3,500	3,000
	Rhode Island – Connecticut Northeast		
NE North-South	New Hampshire - Boston		
	New Hampshire -Massachusetts Central		
	Vermont – Massachusetts West	2,725	2,725
	Hydro Quebec – Massachusetts Central		

Single Path Transmission Limits			
Zone A	Zone B	A to B (MW)	B to A (MW)
NE Maine Southeast	NE New Hampshire	1,900	0

- An alternative view of transmission constraints in New Hampshire is provided by a study that is used to assess the economics of energy efficiency investments.
- The Avoided Energy Supply Components in New England study reviews New Hampshire transmission constraints as they are represented in the model that's used to estimate the value of these energy efficiency investments.

Source: Avoided Energy Supply Components in New England 2021 Report, Synapse

New Hampshire a net exporter of electricity

- With annual electricity consumption of about 11 million MWh, about 90% of the state's electricity requirements can be supplied by the 1,250 MW Seabrook nuclear power plant. With this and the output of various generating units including two large natural gas-fired combined cycle units (1,200 MW), the 450 MW Merrimack generating station and various renewable power plants, New Hampshire historically has been a net exporter.
- This suggests that the transmission lines that connect New Hampshire to the rest of the ISO-New England grid are likely to be more heavily loaded, leaving less capacity for the export of OSW generation.
- However, the retirement of existing fossil generating units in New Hampshire could reduce the loadings on these transmission lines and create more opportunities for the export of OSW generation.

New Hampshire a net exporter of electricity

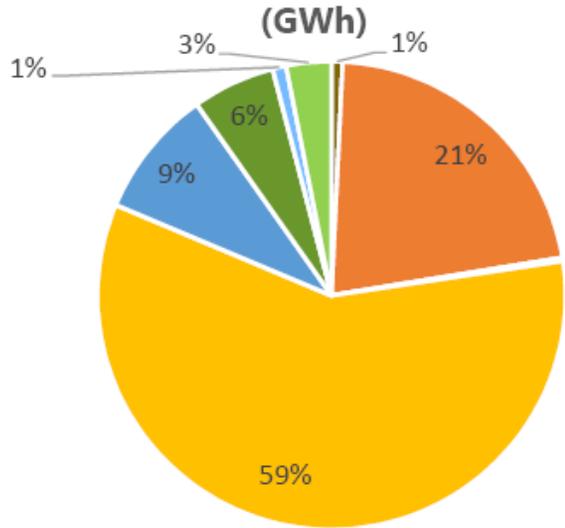
- New Hampshire has been a net exporter of electricity for the past decade, generating more electricity in NH power plants than what is consumed in the state. On average, between one-third and half of the electricity generated in New Hampshire is exported to other states or Canada.

New Hampshire Electricity 2019 Data (MWh)				
Total net generation	Total retail electricity sales	Estimated Losses	Total Electricity Requirements	Net interstate exports
18,026,595	10,711,657	580,828	11,292,485	6,623,325

Source: US EIA Data

New Hampshire and ISO-NE Resource Mixes

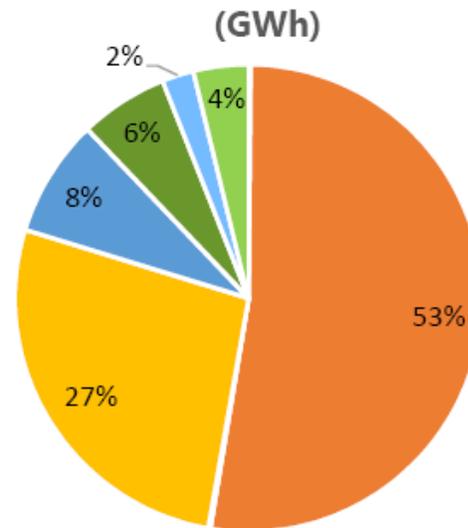
2020 New Hampshire Electricity Resource Mix



■ Coal ■ Natural gas ■ Oil ■ Nuclear ■ Hydro ■ Biomass ■ Solar ■ Wind

Source: US EIA Data

2020 New England Electricity Resource Mix



■ Coal ■ Natural Gas ■ Oil ■ Nuclear ■ Hydro ■ Biomass ■ Solar ■ Wind

Source: ISO-NE
Excludes imports

Northeast Massachusetts Transmission



- As indicated, there are a limited number of 345 kV points of interconnection (POIs) in Massachusetts that are close to the coast.
- These include the West Amesbury substation just South of the New Hampshire border, various POIs in the Boston area, which have been identified in other studies including Mystic and K Street.
- Another possible POI is Pilgrim, site of the retired nuclear generating station, which has two 345-kV transmission lines.



Source: ISO-NE

High Level considerations with Massachusetts POIs

- Other than West Amesbury, Massachusetts POIs for offshore wind from the Gulf of Maine are likely to have considerably longer cable runs than would be necessary to interconnect in New Hampshire. This increases their cost and environmental impacts.
 - Clearly, the respective length of these cable runs will be determined by the location of the wind energy areas established by BOEM.
- At higher levels of offshore wind development in the Gulf of Maine the more southerly Massachusetts POIs, closer to Boston, may be attractive given their anticipated greater “take away” capacity and the corresponding delivery to a major load center.

2. Interconnecting OSW Generation in NH

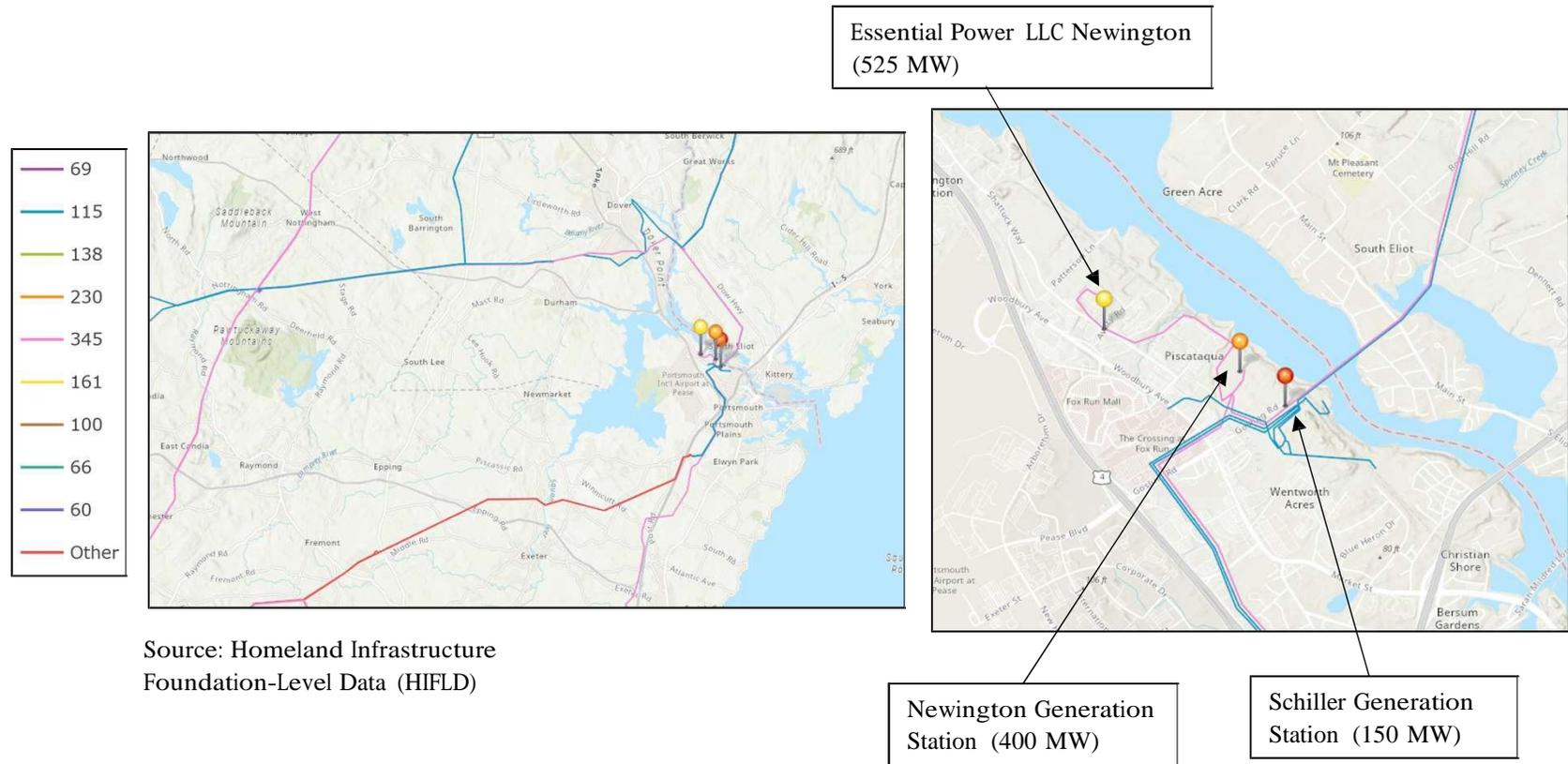
OSW Points of Interconnection

- Establishing preferred point of interconnection for offshore wind generation typically involves assessing the tradeoffs associated with the length of required transmission cable runs, with shorter cable lengths preferred given lower costs and reduced environmental impacts, versus the relative attractiveness of points of interconnection (POI), which considers the suitability of the POI in terms of the available take away capacity and environmental impacts.
- Some of the most attractive POIs are recently retired generating facilities given that they have available transmission capacity that can be utilized, limiting the need for potentially expensive transmission system upgrades.
- With these retired or retiring generating facilities typically being fossil generating units in Southern New Hampshire, they are typically located on coastal waterways given requirements for cooling water. These facilities provide ready access for the subsea transmission cables that would deliver the offshore wind generation from the Gulf of Maine.
 - o These criteria, in particular a location adjacent to coastal waterways, rule out the Merrimack Generating Station given its location in Bow, New Hampshire.

Possible OSW transmission POIs

- Given these criteria there are a number of possible POIs in Southern New Hampshire including:
 1. Schiller Generation Station (150 MW) in Portsmouth on the Piscataqua River, which closed earlier this year.
 2. Newington Generation Station (400 MW) in Newington, also on the Piscataqua River, a quarter mile Northwest of Schiller.
 3. The Essential Power LLC Newington combined cycle gas turbine facility, a 525 MW natural gas-fired unit also near the Piscataqua River and less than a mile from Newington Station.
- Both the Newington Station and Newington Energy are currently operating. However, as an older, less efficient fossil generation unit with higher staffing requirements, Newington Station is likely to retire before Newington Energy. The rated capacity of Schiller and Newington Station combined represents about 550 MW, suggesting that with the retirement of Newington Station the takeaway capacity in the Portsmouth area, where the two generating units are located, should be about 550 to 600 MW.
 - o Further analysis is required to determine how much offshore wind generation could be landed in the Portsmouth area without the need for major transmission upgrades.

Portsmouth Area Transmission and Generation



Possible OSW Transmission POIs

- Another possible POI is near the Seabrook Nuclear Generating Station (Seabrook).
- Given its relative size and requirements for redundancy, Seabrook is a major transmission interconnection point. However, the available transmission infrastructure was built to reliably deliver the output of Seabrook to New England load centers. As indicated by the rating of the Seabrook transmission interface, there's relatively little surplus transfer capability for Seabrook. This isn't surprising given that these facilities were built to interconnect Seabrook and the rated capacity of the unit has been increased from 1,150 MW to about 1,250 MW.
- Seabrook was originally designed as a two unit generating station. However, the second unit was canceled after construction was about 25% complete. There are 3 x 345 kV transmission lines that connect Seabrook to the rest of the ISO-NE transmission grid. With all three 345 kV transmission lines in service there's additional available interconnect capacity at Seabrook. However, transmission planning considers the loss of one of these 345 kV lines as an N-1 contingency and under such conditions there's little to no available additional transfer capability at Seabrook. In addition, the Nuclear Regulatory Commission has standards for the interconnection of nuclear generating stations that would need to be considered.
 - o Here as well further analysis is required to determine how much offshore wind generation could be landed near Seabrook area without the need for major transmission upgrades. However, our initial assessment suggests that there's little available "surplus" transmission capacity in the area.

Summary of Potential OSW Interconnection Points

Power Plant Facility	Capacity (MW)	Additional Information
Schiller Station	155	Recently a coal and wood burning plant, then was retired in the summer of 2020. Located in Portsmouth, NH
Seabrook Nuclear Power Plant	1,250	Operating license until 2050
Essential Power Newington	525	No planned retirement, efficient combined cycle gas turbine facility
Newington Power Plant	400	No planned retirement

ISO-NE can assess interconnection capability

- Pursuant to a 2019 request by New England State Committee on Electricity (NESCOE) ISO-NE conducted a study on the impacts of the transmission system and wholesale electricity markets of up to 8,000 MW of OSW by 2030, including the 1,000 MW already under-contract at that time. https://www.iso-ne.com/static-assets/documents/2020/02/a6_nescoe_2019_Econ_8000.pdf
- For this study, ISO-NE developed future interconnection scenarios for OSW based on interconnection points identified by OSW developers as reflected by interconnection queue requests. Based on the results of several of these interconnection studies, ISO-NE identified the approximate MW quantities that could interconnect without major transmission upgrades.
- Because this study focused on POIs where there already interconnection queue requests for offshore wind farms proposed in the MA Wind Energy Area south of Nantucket & Martha's Vineyard, this study didn't include POIs for offshore wind developed in the Gulf of Maine.
- NESCOE or New Hampshire, Maine and Massachusetts could request that ISO-NE conduct such a study for POIs that are more appropriate for offshore wind from the Gulf of Maine.

ISO-NE conducting additional studies

- In October 2020, NESCOE issued a Vision Statement for a clean, affordable, and reliable 21st century regional electric grid that necessitated significant changes in the regional energy system. One area where such changes were called for was with respect to Transmission System Planning.
- The ISO-NE Board of Directors responded to the Vision Statement's transmission component by committing that ISO-NE would conduct a high-level, long-term transmission study, the 2050 Transmission Study. The 2050 Transmission Study will inform the region of the amount, type and high level cost estimates of transmission infrastructure that would be necessary to cost effectively incorporate clean-energy and distributed energy resources and to meet New England states' energy policy requirements and goals, including economy wide decarbonization.
- In 2020, NEPOOL initiated the Future Grid Reliability Study, Phase I. This was in response to NESCOE's 2019 request to ISO-NE to dedicate market development and planning resources in 2020 to support states and stakeholders in analyzing and discussing potential future market frameworks that contemplate and are compatible with the implementation of state energy and environmental laws. This Study is a series of engineering and economic analyses that uses NESCOE and stakeholder defined scenarios to identify grid reliability challenges that could occur in the year 2040 in light of state energy mandates and policies. ISO-NE will issue the Phase I report in the first quarter of 2022.
- These reports may assist New Hampshire in better understanding offshore wind interconnection challenges and opportunities.

Implications of OSW Generation to New Hampshire

- Interconnecting offshore wind generation from the Gulf of Maine is likely to affect New Hampshire in a number of different ways.
- First, the delivery of large volumes of offshore wind from the Gulf of Maine in New Hampshire should reduce the risk of increases in energy prices from transmission congestion.
 - o The electric energy market administered by ISO-NE has locational marginal prices (LMPs), where energy prices can vary across the grid when there are transmission constraints or differences in marginal losses.
 - o The injection of significant volumes of offshore wind generation from the Gulf of Maine will reduce the risk of transmission congestion in New Hampshire that can lead to higher prices during high load periods and can increase the likelihood of lower LMPs when offshore wind output is high.
- Second, interconnecting offshore wind will require upgrades to the existing transmission infrastructure. The magnitude of the required investment depending on the interconnection point as well as the interconnection capacity.
- Finally, to date, locales that have accepted cable landfall infrastructure for offshore wind have negotiated significant Community Benefit Agreements with the project developers

Transmission investment has overall economic benefits

- Onshore transmission facilities will need to be modified with a corresponding investment. This investment for OSW interconnection is likely to result in in-state employment and economic development benefits.
- Economic multipliers and the magnitude of these investments vary. For an example \$20 million invested in interconnecting offshore generation to the onshore grid in New Hampshire, approximately \$87 million in GDP and 600 FTE construction period jobs would be expected.

3. Models for Transmission Development

Alternative Models for Transmission Development

- Various models could be used to enable the required transmission development.

Generator Lead Line/Radial Approach

- Absent policy intervention, offshore wind interconnection facilities would likely be funded by the owner of the offshore wind generation that requires these interconnection facilities. This is the traditional model that is employed to develop and fund interconnection facilities. Under this approach the generation project developer identifies a preferred location for interconnecting the project to the onshore grid and accepts responsibility for the cost of these facilities.
- This model is relatively straightforward and is favored by some because of the strong incentives that it provides to minimize these interconnection costs in the short term, as well as simplifying the direct comparison of offshore wind projects when their interconnection costs are included as part of the total project cost and required project pricing.
- One disadvantage of this approach is that it doesn't necessarily result in the most efficient, cost-effective utilization of the available existing transmission infrastructure when high levels of offshore wind deployment are anticipated in the long term. For example, if the lowest cost interconnection alternative has the capacity to interconnect 1,100 MW, but the project proposing to use this interconnection point is only 800 MW then it is conceivable that there will be 300 MW of low-cost interconnection capability that is effectively stranded.

Alternative Models for Transmission Development

Coordinated Approaches

- An alternative approach that better addresses this issue is coordinated transmission development to support the interconnection of the amount of offshore wind that is anticipated to be developed.
- Coordinated approaches seek to minimize the total interconnection costs of all offshore wind projects and can also reduce the environmental impacts associated with the landing of this OSW generation. A clear challenge of such an approach is realizing sufficient cost savings to compensate for anticipated risks of potentially pre-building interconnection facilities. To produce such savings generally requires that there be a sufficiently large volume of offshore wind to be developed that the required interconnection facilities can realize economies of scale or ensure that the lowest cost interconnection facilities are fully utilized. With state offshore wind targets often increased incrementally, this can result in a piece meal development of the required transmission infrastructure. Another complicating factor is other than for large states with sizable electricity demand (e.g., New York with a 9,000 MW offshore wind target) that the savings from coordinated transmission development can require that nearby states work together to plan these interconnection facilities. This requires agreements to share the cost of these facilities and a full understanding of the future offshore wind procurement goals of the state.
- Offshore wind developers generally prefer the generator lead line approach given that it best allows them to manage the risks of interconnecting their project to the onshore grid, which is obviously critical to successful project development. However, as noted above, the lowest cost POIs requiring the least complex on shore upgrades will be utilized by the first projects; developers of later projects will face substantially great challenges.

New Jersey and PJM evaluating planned transmission for OSW

- New Jersey has requested that the regional transmission organization that manages and plans the transmission grid in which it participates, the PJM Interconnection (PJM), use a framework that PJM developed to consider state public policy objectives in its transmission planning process. Specifically, New Jersey requested that PJM evaluate competing proposals that would enable the interconnection of the state's 7,500 MW offshore wind goal.
- Proposals are due in the middle of August and the PJM is scheduled to make preliminary recommendations to New Jersey in Q4 2021, with final recommendations in 2022. New Jersey ratepayers will have cost responsibility any transmission solutions that it selects. However, it could determine that none of these proposals are in customers' interests.
- New Jersey's experience warrants following. As discussed, the relative attractiveness of such solutions is strongly influenced by the volume of offshore wind to be developed, such that what is practical for New Jersey may not be for New Hampshire.

4. Data Requirements & Future Research Needs

Data requirements and future research needs

- This report provides a high-level assessment of potential transmission issues posed by the interconnection of offshore wind generation from the Gulf of Maine to New Hampshire. The need for and importance of additional analysis of these issues will depend in large part on the underlying level of offshore wind development in the Gulf of Maine.
- As discussed above, the need for coordinated transmission development depends in large part on the magnitude of offshore wind ambitions as well as the severity of the underlying transmission constraints.
 - Alternatively, transmission development can occur under the generator tie-line model discussed above where individual offshore wind developers identify preferred transmission interconnection points. This is how transmission development for offshore wind has occurred so far in New England. There have been various ISO-NE and other studies that evaluated higher levels of offshore wind development, but these haven't resulted in the development of transmission facilities to support this development.
- This initial analysis suggests that the New Hampshire transmission network has the ability to connect relatively modest amounts of offshore wind generation. However, should New Hampshire seek to connect large volumes of offshore wind (e.g., significantly greater than 1,000 MW) then further analysis of interconnection options for the Gulf of Maine offshore wind would be appropriate. This could occur along the lines of the NESCOE request to ISO-NE for a study of interconnection capability focused on the Gulf of Maine.



John Dalton
President
978.831.3368
jdalton@poweradvisoryllc.com

**APPENDIX D – STATE OF NH SEAFOOD HARVESTING
INDUSTRY**

State of NH Seafood Harvesting Industry 2021 Report

Prepared by NH Sea Grant
November 2021



Table of Contents	2
Executive Summary	3
1. Introduction	5
2. Fisheries Economics	7
3. Fisheries	10
3.1 North Atlantic Commercial Fishery Landings	10
3.2 New Hampshire Commercial Fishery Landings	12
3.3 North Atlantic Recreational Maritime Catch	15
3.4 New Hampshire Recreational Maritime Catch	17
4. Status of Stocks	20
4.1 American Lobster Stock	20
4.2 NEFMC Sustainability Index	21
5. Conclusion	24

Primary findings for New Hampshire marine fishery economic activity:

- The commercial lobster fishery and recreational fishing sector are stable
- The commercial groundfish fishery has declined significantly in weight and total value
- An area of concern is the increasing reliance of the commercial fishing industry on one species, American lobster.

Total economic value due to marine fishing (both recreational and commercial) in NH was \$125 million in 2017 supporting 3,200 NH jobs. In 2010, the marine fishing economy contributed \$76 million to the NH economy and supported 2,100 NH jobs. The NH commercial fishing industry directly generates approximately 920 full and part-time jobs. Total economic activity generated from the NH commercial fishing industry is estimated to be \$90 million supporting an overall 2,700 full and part-time jobs. Total economic activity generated from the NH recreational marine fishing industry is estimated to be \$35 million (about 40% of the value of the commercial fishing industry) supporting an overall 500 full and part-time jobs. Additional economic assessment and new data sources are required to more accurately estimate and monitor the size and health of the NH local seafood and recreational fishing economy.

In 2020, landings by commercial fishermen at ports in NH were 3.1 thousand metric tons valued at \$27 million. When compared to 2019, the catch value was \$11.8 million less (down by 30.4%) and the catch was 1.6 thousand metric tons less (down by 34.7%). A decade ago, NH harvested 5.4 thousand metric tons of seafood worth \$24 million. In 2020, the marine recreation catch by anglers in NH via onshore or boat was estimated to be 673 metric tons (approximately 20% of the total commercial catch weight). This is likely to have been lower than the catch in 2018 and 2019 although there is uncertainty in the exact

recreational catch. It is also possible that the catch is lower than in 2010 when the best estimate was higher at 1,257 metric tons, but again is a number with high uncertainty.

During the past decade, the Northeast has become more dependent on American lobster (*Homarus americanus*) as a proportion of catch weight and economic value. Across the three North Atlantic states (ME, MA, and NH), lobster value increased from 40% of total value to 47% of total landed value and from 22% of catch weight to 29% from 2010 to 2020. NH has become even more dependent than the overall region on the lobster fishery. Between 2010 and 2020, the percentage of commercial revenue from lobster grew from 72% of landed value to 93% of landed value and from 31% of catch weight to 69% of catch weight.

NOAA scientists state that the past 30-year trend for seafood in general in New England has been negative, however, the current overall regional seafood ecosystem has stabilized and is giving some indications of improvement. A sustainability index for fish stocks managed by New England Fishery Management Council is currently at 70%, when in 2010 it was at 60% (with 100% being the highest score).

In general, there has been a divergence with lobster landed weight increasing, while finfish landings have declined. This is likely due to increased abundance of lobsters in the region while many species of fish are in management plans that restrict catch limits to support rebuilding the stock. Projections of lobsters predict an abundance of lobsters in the Gulf of Maine and Georges Bank region (areas that NH fishermen would be likely to lobster) for the next decade. Nine of the ten fish stocks that are overfished in New England currently have management plans in-place to rebuild the stocks. From an ecosystem perspective, the region is expected to continue to support the lobster industry in NH for the next decade and there is potential for additional growth if overfished fish stocks are successfully rebuilt.

1. Introduction

In 2011, the first State of NH Seafood Harvesting Industry report through NH Sea Grant and UNH Cooperative Extension was produced. The purpose of that report was to document the importance of the seafood harvesting industry to the state. In this 2021 report, the intent is to provide an update on how the fishing industry's contribution to NH's economy has changed over the past decade since the report's original release.

As was the case in the original 2011 report, this new report provides information on the contribution to jobs and economic value of the fishing industry, statistics of the commercial seafood harvest, and measures of fishery health. New to this update is inclusion of recreational saltwater coastal catch and its impact on the NH economy. The economic impact of commercial and recreational fishing activities in NH is also reported in terms of employment and value-added impacts.

A significant portion of the data used in this analysis comes from the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries). Each year, this U.S. government agency compiles key fisheries statistics from the previous year into an annual snapshot documenting fishing's importance to the nation. The NOAA Fisheries report provides landings totals for both domestic recreational and commercial fisheries by species and is a source of indicators of the economic impact of seafood in the U.S.¹

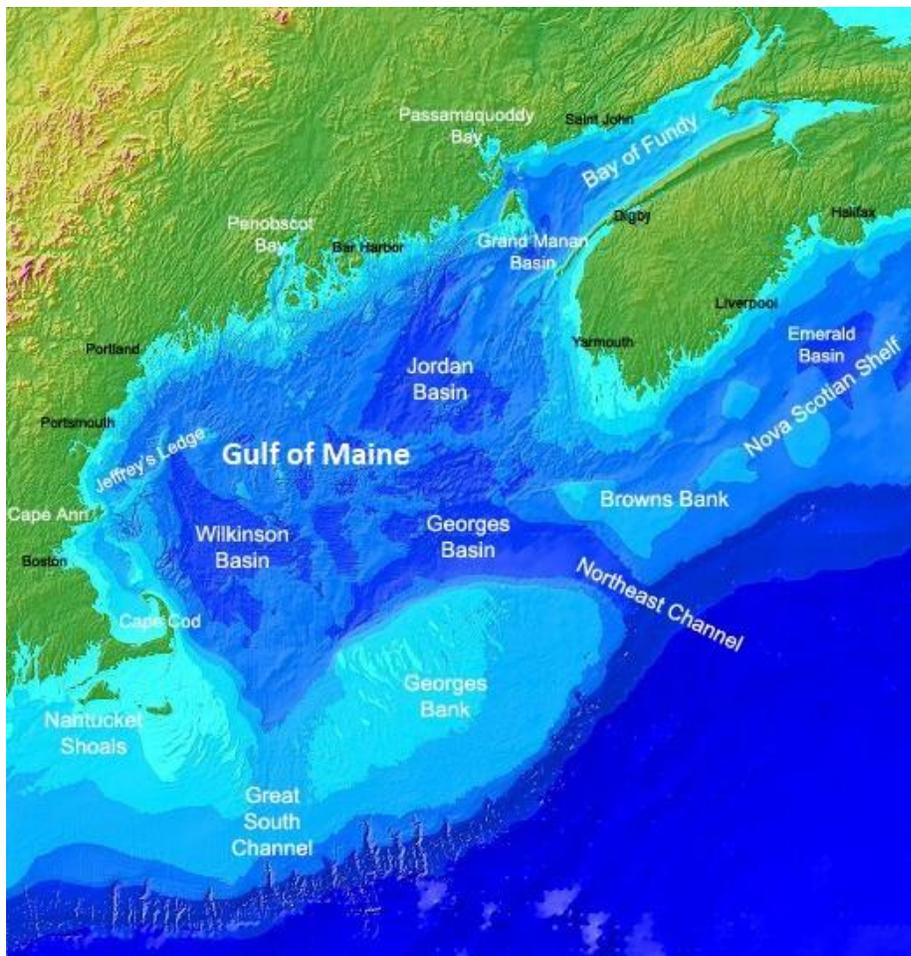
A review of the economic data provided here by NH fishers suggests that more work is necessary to more accurately ground-truth and further resolve the true economic value of the local seafood and recreational fishing economy. In the opinion of NH fishers, the NOAA data may overestimate employment while underestimating the direct and indirect value of fishing in the state. Therefore, new data sets should be generated in future analyses to

¹ About NOAA Fisheries. NOAA. Accessed September 21, 2021. Available online at <https://www.fisheries.noaa.gov/about-us>

improve our ability to measure and track the health and impacts of the local seafood and fishing economy in NH.

This 2021 NH Sea Grant report considered both economic and ecosystem-based factors to help assess the industry and benchmark it to the neighboring states of Maine and Massachusetts who share the same fishing grounds—specifically, the Gulf of Maine (GOM) and Georges Bank (GBK) fishing grounds.

Figure 1.1 Map of New England Fishing Grounds



The original uploader was Canadaolympic989 at English Wikipedia. - Transferred from en.wikipedia to Commons by Pauk using CommonsHelper., CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=11315034>

2. Fisheries Economics

In 2017, the latest economic data available through NOAA, the marine fishing industry contributed \$125 million in value added to the NH economy. This was 62% greater than the value added in 2010 at \$76.7 million. In 2017, the economic value-added contribution from the commercial harvesting industry was \$90 million (72% of total) and \$34.7 million (28% of total) from recreational on-shore and offshore fishing activity. In 2010, the economic value-added contribution from the commercial harvesting industry was \$60 million (78.5% of total) and \$16.5 million (21.5% of total) was from recreational on-shore and offshore activity. All dollar values are reported in 2020 dollars to allow for inflation adjusted comparisons.

Table 2.1 Economic value added in NH by marine fishing industry (\$2020 millions)

Type	2010	2017	% Change
Commercial	\$60.2	\$90.1	49.7%
Recreational	\$16.5	\$34.7	110.7%
Total	\$76.7	\$124.9	62.8%

Prepared from NOAA Fisheries

Table 2.2 Total jobs in NH supported by marine fishing industry

Type	2010	2017	% Change
Commercial	1,814	2,665	46.9%
Recreational	261	497	90.4%
Total	2,075	3,162	52.4%

Prepared from NOAA Fisheries

In 2017, the commercial fishing industry directly employed 920 workers (either full or part-time) paying \$18.3 million in income. The complete fishery supported 2,665 NH jobs including seafood processors, wholesalers and retail paying \$65.9 million in income. In 2010, the commercial fishing industry directly employed 620 workers (either full or part-time) paying \$18.8 million in income. The complete fishery supported 1,814 NH jobs

including seafood processors, wholesalers. NOAA did not report income for the complete commercial fishing industry in NH in 2010.

Table 2.3 Economic Impact of NH commercial fishing industry in 2017

Sector	Jobs	Income (\$2020 millions)	Value added (\$2020 millions)
Commercial Harvesters	920	\$18.3	\$28.5
Seafood Processors & Dealers	211	\$10.8	\$13.9
Seafood Wholesalers & Distributors	82	\$4.4	\$5.8
Retail	1,452	\$32.4	\$41.9
Total	2,665	\$65.9	\$90.1

Prepared from NOAA Fisheries

Table 2.4 Economic Impact of NH commercial fishing industry in 2010

Sector	Jobs	Income (\$2020 millions)	Value added (\$2020 millions)
Commercial Harvesters	620	-	\$18.8
Seafood Processors & Dealers	145	-	\$9.4
Seafood Wholesalers & Distributors	55	-	\$3.8
Retail	995	-	\$28.2
Total	1,815	-	\$60.2

Prepared from NOAA Fisheries

In 2017, the recreational marine fishing industry (for-hire boats, private boats, and on-shore angler activity) supported 497 workers (either full or part-time) paying \$22 million in income. This also included economic activity due to expenditures for durable equipment including fishing gear and boating equipment. In 2010, the recreational marine fishing industry supported 261 workers (either full or part-time) paying \$10.3 million in income.

Table 2.5 Economic Impact of NH recreational marine fishing industry in 2017

Sector	Jobs	Income (\$2020 millions)	Value added (\$2020 millions)
For-Hire	100	\$3.8	\$6.0
Private Boat	93	\$4.6	\$6.7
Shore	185	\$7.7	\$13.3
Total Durable Expenditures	119	\$6.1	\$8.7
Total	497	\$22.2	\$34.7

Prepared from NOAA Fisheries

Table 2.6 Economic Impact of NH recreational marine fishing industry in 2010

Sector	Jobs	Income (\$2020 millions)	Value added (\$2020 millions)
For-Hire	95	\$2.8	\$4.8
Private Boat	30	\$1.1	\$2.0
Shore	33	\$1.1	\$1.9
Total Durable Expenditures	103	\$5.4	\$7.8
Total	261	\$10.4	\$16.5

Prepared from NOAA Fisheries

The Bureau of Labor Statistics through their Quarterly Census of Wages provides wage information for those involved in the fishing industry (NAICS 1141). Massachusetts and New Hampshire do not provide average annual pay for the fishing industry due to disclosure requirements, but Maine does. In 2020, the average annual employee pay in the fishing industry in Maine was \$59,101. For comparison, this was 90% of the average annual private industry wage in NH in 2020 of \$66,038.²

² Quarterly Census of Employment and Wages. Bureau of Labor Statistics. Available online at <https://www.bls.gov/cew/data.htm>

3. Fisheries

This section of the report provides data on NH commercial fisheries and recreational catch landings and value. This includes comparison to the other two northern maritime New England states (Maine and Massachusetts). All dollar values are reported in 2020 dollars to allow for inflation adjusted comparisons.

3.1 North Atlantic Commercial Fishery Landings

In 2020, landings by commercial fishermen at ports in the North Atlantic states (ME, MA, and NH) was 180.9 thousand metric tons, valued at \$1.1 billion.³ This was a decrease of 12.3 thousand metric tons (down by 6.4%) and a decrease of \$315.1 million (down by 22.3%) compared with 2019. From 2018 to 2019, the overall catch decreased by 35.3 thousand metric tons (down by 15.5%) but the overall value of the catch increased by \$40.6 million (up by 3.0%).

In 2010, the three states harvested 237.1 thousand metric tons of seafood worth \$1.1 billion (\$2020). The change from 2010 to 2020 saw a decrease in harvest weight of 56.2 thousand metric tons (down by 23.7%) and a decrease in total economic value of \$38.0 million (down by 3.3%). The longer-term trend during the past decade has been an average decrease in the catch of approximately 6 thousand metric tons per year with an average \$11.6 million annual increase in catch value per year. The landed value of the catch broke from the longer-term trend of rising annual harvest value in 2020 by showing decline. A major contributing factor to the drop in catch volumes and landed value is the seafood market disruption resulting from the COVID pandemic.⁴

³ Landings. NOAA Fisheries. Available online at <https://www.fisheries.noaa.gov/foss>

⁴ COVID-19 Special Investigation Report: Impacts to New England's Commercial Fisheries. Global Resilience at Northeastern University. Available online at <https://globalresilience.northeastern.edu/publications-whitepaperseries-covid-19-special-i6vestigation-report-2020-9/>

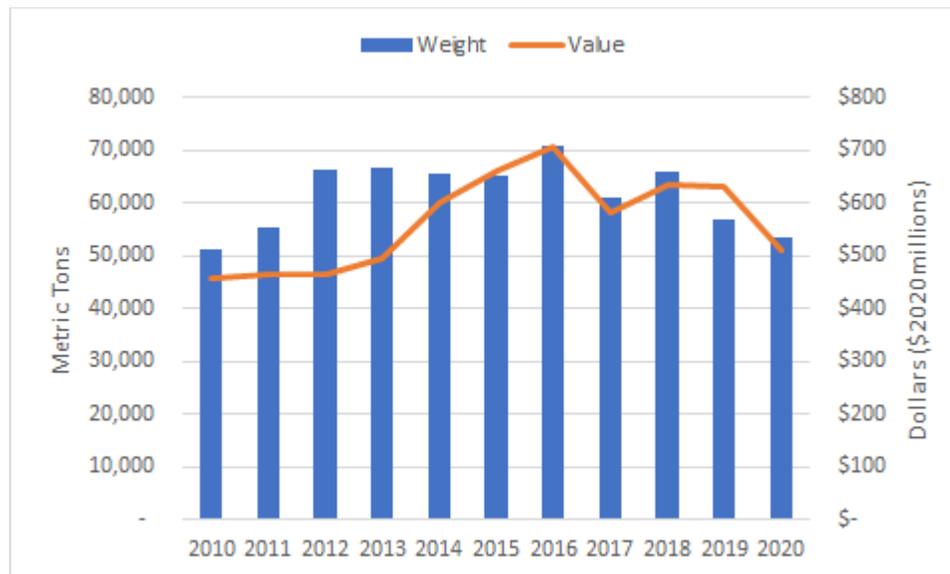
Table 3.1.1 Commercial domestic landings by state

State	2018			2019			2020			% change 2019 to 2020		
	Metric tons	Dollars (\$2020 millions)	\$2020 per pound	Metric tons	Dollars (\$2020 millions)	\$2020 per pound	Metric tons	Dollars (\$2020 millions)	\$2020 per pound	Metric tons	Dollars (\$2020 millions)	\$2020 per pound
ME	114,384	\$665.1	\$2.64	82,222	\$685.0	\$3.78	74,400	\$515.2	\$3.14	-9.5%	-24.8%	-16.9%
MA	109,652	\$667.7	\$2.76	106,245	\$689.5	\$2.94	103,376	\$555.9	\$2.44	-2.7%	-19.4%	-17.1%
NH	4,508	\$39.7	\$4.00	4,714	\$38.7	\$3.73	3,080	\$27.0	\$3.97	-34.7%	-30.4%	6.6%
Total	228,544	\$1,372.6	\$2.72	193,182	\$1,413.2	\$3.32	180,855	\$1,098.1	\$2.75	-6.4%	-22.3%	-17.0%

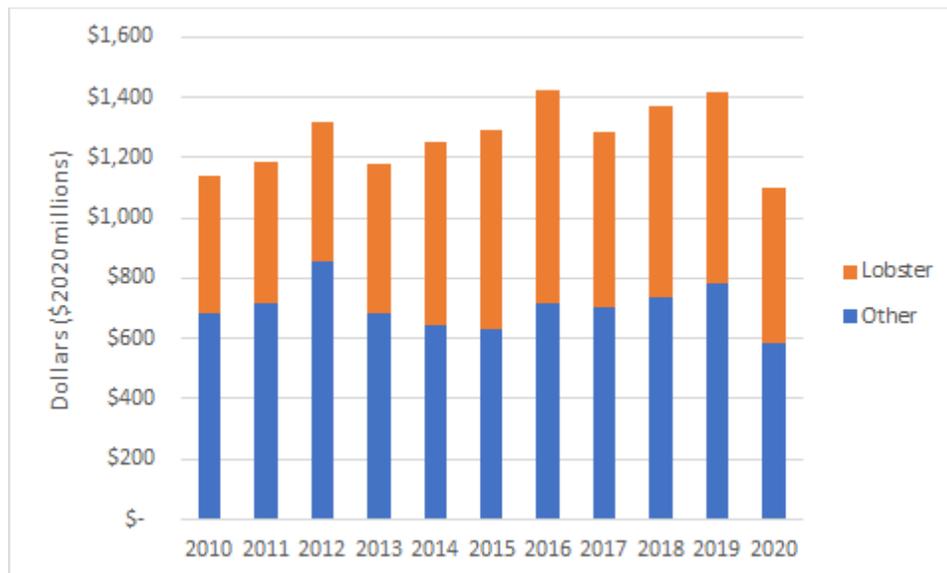
Prepared from NOAA Fisheries Annual commercial landing statistics

American lobster (*Homarus americanus*) supports one of the most valuable commercial fisheries in the Northeast U.S. (MA, ME, and NH), with an annual revenue of \$512 million in 2020 (47% of total catch value). In 2010, lobster accounted for \$455 million (40% of total catch value). In 2015, the percentage of revenue derived from lobster landings peaked at 51% (\$661 million). For the region, the landing weight of lobster was 51.1 thousand metric tons (22% of total catch weight) in 2010 and 53.2 thousand metric tons (29% of total catch weight) in 2020.

Figure 3.1.1 North Atlantic commercial catch of lobster from 2010 to 2020



Prepared from NOAA Fisheries Annual commercial landing statistics



Prepared from NOAA Fisheries Annual commercial landing statistics

3.2 New Hampshire Commercial Fishery Landings

In 2020, landings by commercial fishermen at ports in NH was 3.1 thousand metric tons valued at \$27 million. This was a decrease of 1.6 thousand metric tons (down by 34.7%) and a decrease of \$11.8 million (down by 30.4%) compared with 2019. From 2018 to 2019, the overall catch increased by 0.2 thousand metric tons (up by 4.6%) but the overall value of the catch decreased by \$1 million (down by 2.5%)

In 2010, NH harvested 5.4 thousand metric tons of seafood worth \$24 million (\$2020). The change from 2010 to 2020 saw a decrease in harvest weight of 2.2 thousand metric tons (down by 42.5%), but an increase in total economic value of \$2.6 million (up by 10.6%). The longer-term trend during the past decade has been an average decrease in the catch of approximately 150 metric tons per year with an average \$1.3 million annual increase in catch value per year. The landed value of the catch in 2020 broke from the longer-term trend of rising annual harvest value with a decrease. NH accounted for 1.7% of the commercial catch by weight in 2020 out of the North Atlantic states down from 2.3% of the commercial catch volume by weight in 2010.

and \$25.0 million (93% of total landed value). In 2010, the lobster harvest weight was 1.6 thousand metric tons (31% of total catch weight) and \$17.6 million (72% of total landed value). In general, the proportion of the NH commercial catch dependent on lobster by weight and value has been increasing annually since 2005. Over the past decade, the weight and value of commercial species other than lobster has decreased by approximately 70% in both weight and total landed value.

The total harvest price per pound has increased by 91.9% from 2010 to 2020. A major component of this change has been the increased proportion of the catch dependent on lobster which has a higher price per pound. It was \$5.36 in 2020 compared to all other species harvested at \$0.95 per pound. Over the past decade, the price of lobster has risen faster than the rate of inflation increasing by 11.2%, from \$4.82 to \$5.36.

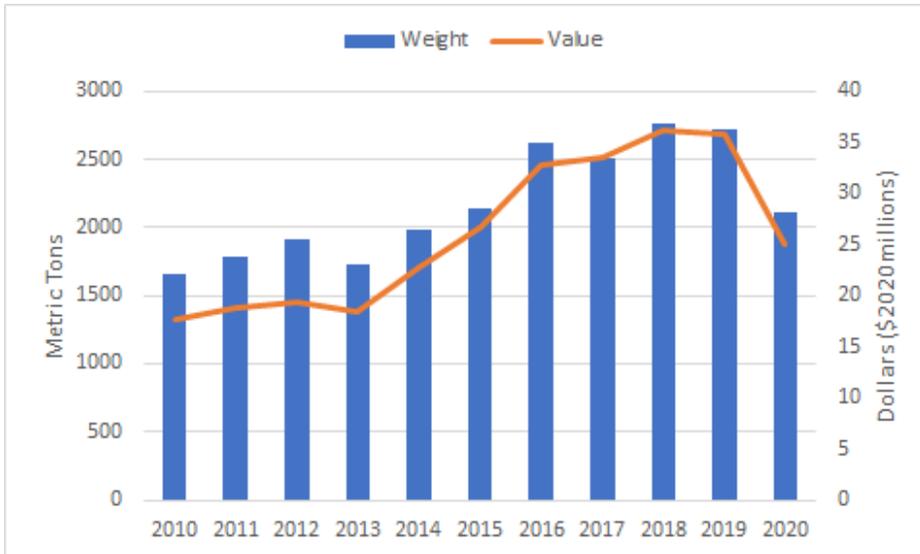
Table 3.2.1 Commercial harvest performance metrics in NH by year

Indicator	2010	2018	2019	2020	% change		
					2018-2019	2019-2020	2010-2020
Total harvest value (\$2020 millions)	\$24.4	\$39.7	\$38.7	\$27.0	-2.5%	-30.4%	10.6%
Total harvest weight (metric tons)	5,353	4,508	4,714	3,080	4.6%	-34.7%	-42.5%
Total harvest price per pound (\$2020)	\$2.07	\$4.00	\$3.73	\$3.97	-6.7%	6.6%	91.9%
Lobster harvest value (\$2020 millions)	\$17.61	\$36.18	\$35.86	\$25.0	-0.9%	-30.4%	41.7%
Lobster harvest weight (metric tons)	1,655	2,759	2,714	2,112	-1.6%	-22.2%	27.6%
Lobster harvest price per pound (\$2020)	\$4.82	\$5.95	\$5.99	\$5.36	0.8%	-10.6%	11.2%
Other species harvest value (\$2020 millions)	\$6.8	\$3.5	\$2.9	\$2.0	-18.9%	-29.5%	-70.3%
Other species harvest weight (metric tons)	3,697	1,749	2,000	968	14.3%	-51.6%	-73.8%
Other species harvest price per pound (\$2020)	\$0.83	\$0.92	\$0.65	\$0.95	-29.0%	45.6%	14.1%

Prepared from NOAA Fisheries Annual commercial landing statistics

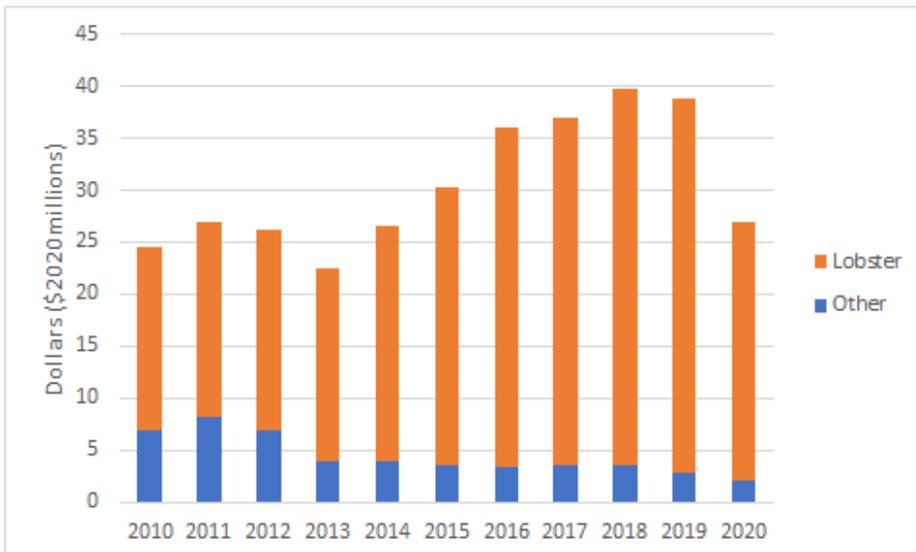
number unknown due to reporting confidentiality). This appears to be down from at least 19 different commercial species landed in 2019 and at least 25 different species landed in 2010. The top five species in 2020 by total landed value were: 1) lobster, 2) bluefin tuna, 3) pollock, 4) haddock, and 5) goosefish.

Figure 3.2.1 NH commercial catch of lobster from 2010 to 2020



Prepared from NOAA Fisheries Annual commercial landing statistics

Figure 3.2.2 Value of NH commercial catch from 2010 to 2020



Prepared from NOAA Fisheries Annual commercial landing statistics

Table 3.2.2 Commercial harvest by species in NH in 2019 and 2020

Species	2019			2020			Change 2019-2020		
	Metric tons	Dollars (\$2020 millions)	\$2020 per pound	Metric tons	Dollars (\$2020 millions)	\$2020 per pound	Metric tons	Dollars (\$2020 millions)	\$2020 per pound
American Lobster	2,713.9	\$35.9	\$5.99	2,112.4	\$25.0	\$5.36	-22.2%	-30.4%	-10.6%
Bluefin Tuna	54.8	\$0.6	\$5.19	56.5	\$0.5	\$3.81	3.1%	-24.3%	-26.6%
Pollock	79.4	\$0.3	\$1.56	102.4	\$0.3	\$1.25	28.9%	3.5%	-19.7%
Haddock	48.3	\$0.1	\$1.26	120.4	\$0.3	\$1.08	149.2%	113.7%	-14.3%
Goosefish	261.6	\$0.3	\$0.55	157.5	\$0.2	\$0.53	-39.8%	-41.9%	-3.5%
Atlantic Cod	44.7	\$0.2	\$2.51	30.5	\$0.2	\$2.69	-31.6%	-26.5%	7.4%
Sea Scallop	16.2	\$0.4	\$10.90	2.9	\$0.1	\$11.38	-82.1%	-81.3%	4.3%
Silver Hake	88.0	\$0.1	\$0.72	32.7	\$0.1	\$0.82	-62.9%	-57.6%	14.3%
Winter Flounder	6.6	\$0.0	\$2.48	2.8	\$0.0	\$1.72	-58.3%	-71.1%	-30.7%
Yellowtail Flounder	8.8	\$0.0	\$1.87	6.5	\$0.0	\$0.80	-25.9%	-68.2%	-57.1%
American Plaice Flounder	6.9	\$0.0	\$1.80	4.3	\$0.0	\$1.26	-37.5%	-56.3%	-30.1%
Atlantic Halibut	1.8	\$0.0	\$6.96	1.7	\$0.0	\$6.21	-7.3%	-17.3%	-10.8%
Cusk	1.2	\$0.0	\$1.21	0.9	\$0.0	\$0.83	-24.0%	-47.8%	-31.4%
Acadian Redfish	0.9	\$0.0	\$0.75	2.5	\$0.0	\$0.65	174.0%	135.5%	-14.0%
Witch Flounder	5.2	\$0.0	\$2.24	12.8	\$0.0	\$1.68	147.0%	85.5%	-24.9%
Jonah Crab	32.1	\$0.0	\$0.61	-	-	-	-	-	-
White Hake	51.4	\$0.2	\$1.34	-	-	-	-	-	-
Winter Skate	6.0	\$0.0	\$0.27	-	-	-	-	-	-
Withheld For Confidentiality	1,286.3	\$0.4	\$0.14	433.4	\$0.40	\$0.39	-66.30%	-3.80%	185.40%

Prepared from NOAA Fisheries Annual commercial landing statistics

3.3 North Atlantic Recreational Maritime Catch

In 2020, maritime catch weight by recreational fishermen in the North Atlantic states (ME, MA, and NH) was estimated to be between 3.4 and 10.0 thousand metric tons, with 6.6 thousand metric tons believed to be the most likely. It is likely that this is lower than the recreational catch volume in 2018 and 2019, where the most likely catch weight was 9.2 and 8.9 thousand metric tons respectively. However, it is also possible that there was no statistically significant change in catch volume from 2018 to 2020. Recreational catch is estimated by NOAA Fisheries using a variety of techniques (including surveys and angler intercepts) which introduces uncertainty to the actual catch volume in a given year. In 2010, the estimated catch weight ranged between 9.7 and 36.5 thousand metric tons, with 22.9 thousand metric tons believed to be the most likely. It is likely that the recreational catch weight was higher in 2010 than 2020 and the best estimates would indicate a decrease of 16.3 thousand metric tons (down by 71%). Table 3.3.1 provides the estimated recreation catch volume in the North Atlantic states.

Table 3.3.1 North Atlantic recreational catch volume estimates by state

State	Year	Metric tons		
		Lower Estimate	Expected Estimate	Upper Estimate
Maine	2018	374	947	1,527
	2019	368	876	1,398
	2020	434	1,185	1,982
Massachusetts	2018	4,422	7,532	10,652
	2019	3,674	6,659	9,926
	2020	2,642	4,826	7,037
New Hampshire	2018	409	767	1,135
	2019	440	1,324	2,575
	2020	355	673	1,008

Prepared from NOAA Fisheries Marine Recreational Information Program

In 2020, maritime catch weight by recreational fishermen in New Hampshire was estimated to be between 355 and 1,000 metric tons with 673 metric tons believed to be the most likely. It is likely that this is lower than the recreational catch volume in 2018 and 2019 where the most likely catch weight was 770 and 1,300 metric tons respectively. However, it is also possible that there was no statistically significant change in catch weight from 2018 to 2020. In 2010, the most likely catch weight was 1,257 metric tons, which would be higher than the best estimate of the 2020 catch. However, it is also possible that there was no statistically significant change in catch weight when comparing 2010 with 2020.

In 2020, top species caught were: 1) Atlantic Mackerel, 2) Other cods/hakes, and 3) Pollock accounting for approximately 9 out of every 10 fish caught. There is considerable uncertainty in the actual harvest weight of several specific species caught recreationally as indicated by the Percent Standard Error (PSE) in estimates. This makes some year-to-year comparisons challenging. For example, the estimates indicate that the catch in other tunas/mackerels decreased by 494 metric tons (down by 96%) from 2019 to 2020. However, due to the high standard error for the estimate for each year, one cannot conclude with confidence that there was any difference in the catch for this species between the two years. Out of all the species, the only statistically significant difference in species caught appears to be a decrease in Striped Bass from 2019 to 2020.

Species	2019		2020		Change 2019 - 2020		No CI Overlap
	Metric tons	PSE	Metric tons	PSE	Metric tons	Metric tons	
Other Tunas/Mackerels	515.3	86.3	21.3	70.1	-494.0	-96%	FALSE
Striped Bass	132.1	34.7	13.0	45.2	-119.1	-90%	TRUE
Herrings	64.9	27.5	22.5	41.8	-42.4	-65%	FALSE
Other Rockfishes	13.0	20.8	5.5	36.1	-7.5	-58%	FALSE
Red Hake	10.4	68.7	8.6	76.3	-1.9	-18%	FALSE
Atlantic Cod	11.0	80.5	9.7	51.8	-1.3	-12%	FALSE
Sculpins	0.0	76.3	0.1	63.8	0.1	199%	FALSE
Atlantic Mackerel	254.1	20.0	254.3	24.5	0.1	0%	FALSE
Pollock	78.4	21.6	78.7	30.0	0.2	0%	FALSE
Winter Flounder	3.5	55.0	4.9	63.5	1.4	42%	FALSE
Cunner	0.2	47.0	1.9	44.7	1.7	870%	FALSE
Other Cods/Hakes	241.4	17.1	248.2	13.4	6.8	3%	FALSE

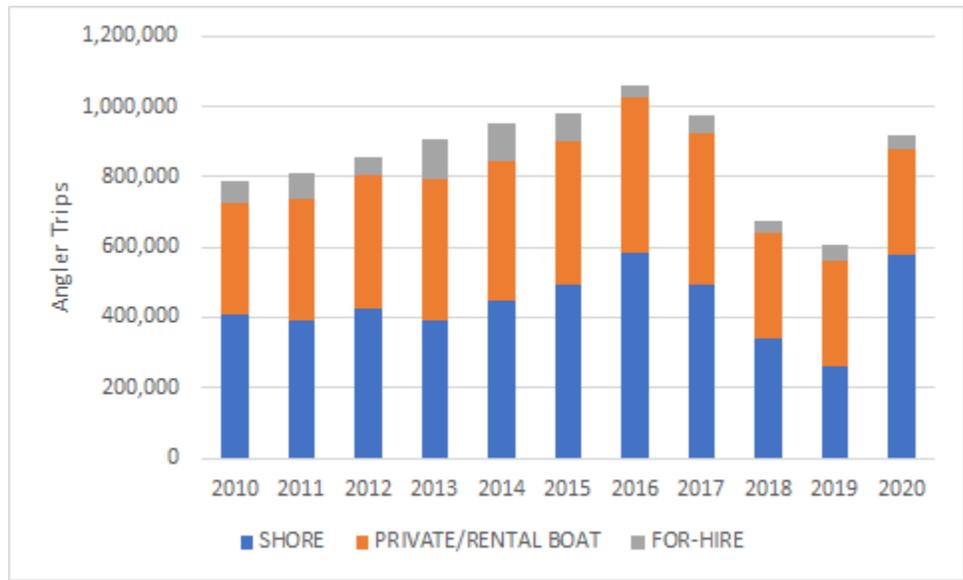
Prepared from NOAA Fisheries Marine Recreational Information Program

The estimated fishing effort in 2020 in NH was 920 thousand angler trips with 851 thousand (93% of all trips) occurring inland or within 3 miles of shore. Shore-based anglers accounted for 578 thousand (63% of all trips), followed by private boats at 297 thousand trips (32% of all trips), and lastly for-hire at 50,000 trips (5% of all trips). In 2018, total estimated angler trips were 609 thousand and in 2019, estimated angler trips were 676 thousand. In 2010, there were 788 thousand estimated angler trips. From 2010 to 2017, there was an upward trend in total angler trips peaking at 1.1 million. Since 2017, there appears to be a downward trend driven by a decrease in shore-based and private boat angler trips.

Mode	INLAND	OCEAN (<= 3 MI)	OCEAN (> 3 MI)	Total
CHARTER BOAT	1,524	2,251	4,956	8,731
PARTY BOAT	2,409	5,767	27,999	36,175
PRIVATE/RENTAL BOAT	127,752	133,276	36,451	297,479
SHORE	383,764	194,143		577,907
Total	515,449	335,437	69,406	920,292

Prepared from NOAA Fisheries Marine Recreational Information Program

Figure 3.4.1 NH catch effort by mode and area from 2010 to 2020



Prepared from NOAA Fisheries Marine Recreational Information Program

4. Status of Stocks

This section of the report discusses the ecosystem and management conditions that impact NH fisheries. In NOAA Fisheries' 2021 State of the Ecosystem Report - New England, it was noted that in the Gulf of Maine (GOM) region, the 30-year trend for seafood production is negative, however the current status is neutral and it does not appear that any ecosystem overfishing (defined as total landings exceeding ecosystem productive capacity) is occurring.

The economic activity of the region is driven by a single species, American lobster, which is subject to resource availability in the GOM and market conditions. Total regional revenue is high due to high lobster prices even though volume is lower. The commercial fleet is shifting towards a reliance on fewer species, but the recreational fishing sector's species diversity is increasing due to increases in southerly species and decreased limits on traditional regional species. The declining trend in revenue from managed species (e.g., groundfish) is most likely due to declines in quotas to allow for stock rebuilding.⁵

4.1 American Lobster Stock

The 2020 American Lobster Benchmark Stock Assessment and Peer Review Report indicates record high stock abundance and recruitment in Gulf of Maine/Georges Bank. The GOM/GBK stock is not overfished nor experiencing overfishing. In the GOM, the fishery takes place primarily in inshore waters, while GBK is predominantly an offshore fishery. Since 1982, the GOM has accounted for 70% of total U.S. landings, increasing to 90% in the past several years. GOM/GBK stock abundance has increased since the late 1980s with an accelerated pace since 2008. Current spawning stock abundance and recruitment are near record highs. Stock projections indicate lobster abundance is expected to continue over the

⁵ 2021 STATE OF THE ECOSYSTEM | New England. NOAA Fisheries. April 26, 2021. Available online at https://apps-nefsc.fisheries.noaa.gov/rcb/publications/soe/SOE_NEFMC_2021_Final-revised.pdf

next 10 years.⁶ Research has implicated that a complex interaction of lobster recruitment, climate change and local conditions in the Gulf of Maine have allowed for the rapid expansion in the lobster stock.⁷

4.2 NEFMC Sustainability Index

An indicator of the fishery stock health is the Fish Stock Sustainability Index (FSSI) published by NOAA Fisheries. The FSSI is a performance-based measure for the sustainability of fish stocks across all U.S. marine fisheries. The stocks were selected by NOAA for their importance to commercial and recreational fisheries. Currently there are 175 fish stocks in the index, which is down from 230 fish stocks in 2011.

The index score increases when NOAA Fisheries determines the status of a stock and when a stock's status improves (either no longer subject to overfishing, no longer overfished, and stock size increases to at least 80 percent of target or is rebuilt). Overfishing occurs when the rate of the removal becomes too high for the fishery stock. A stock is overfished when its population falls below a specific threshold and jeopardizes the long-term viability of a fishery stock. The index is calculated by adding up the stock score of each fish stock. The maximum score each stock may receive is 4.

Table 4.2.1 NOAA FSSI criteria (Source: NOAA Fisheries)

Criteria	Points Awarded
1. "Overfished" status is known	0.5
2. "Overfishing" status is known	0.5
3. Overfishing is not occurring (for stocks with known "overfishing" status)	1.0
4. Stock biomass is above the "overfished" level defined for the stock	1.0
5. Stock biomass is at or above 80% of the biomass that produces maximum sustainable yield (SSB _{MSY})	1.0

⁶ 2020 American Lobster Benchmark Stock Assessment and Peer Review Report. Atlantic States Marine Fisheries Commission. October 2020. Available online at http://www.asmf.org/uploads/file/5fb2c4a82020AmLobsterBenchmarkStockAssmt_PeerReviewReport.pdf

⁷ Goode et al. The brighter side of climate change: How local oceanography amplified a lobster boom in the Gulf of Maine. *Global Change Biology*. July 25, 2019. Available online at <https://doi.org/10.1111/gcb.14778>

From this list of 175 fish stocks, 25 fishing stocks are managed by the New England Fishery Management Council (NEFMC). The value of the NEFMC FSSI is the sum of all 25 individual stock scores. The maximum possible total FSSI score for NEFMC stocks is 100 and would indicate a healthy and sustainable fishery.

Table 4.2.2 NEFMC managed stock management indicators in 2020

Metric	Value	Percentage of Total Stock
Stocks under management	25	100%
Stocks identified as "overfishing"	3	12%
Stocks identified as "overfished"	10	40%
Stocks with biomass under B_{MSY}	13	52%
NEFMC FSSI Index	70	70% (of maximum index)

Prepared from NOAA Fisheries

In 2020, three stocks were designated as experiencing "overfishing": Atlantic Cod (GOM), Atlantic Cod (GBK), and Red hake (Southern GBK). This was 12% of the 25 stocks managed by NEFMC. Ten of the stocks were designated as being "overfished" (40% of managed stocks). Nine of the ten overfished stocks are currently in a program to rebuild stock levels. Thirteen of the stocks had an estimated biomass less than the biomass required for maximum sustainable yield (52% of managed stocks).

The NEFMC FSSI score in 2020 was 70 (70% of total possible value). In 2010, the NEFMC FSSI was 69.5 (60% of the maximum score). The 2021 NEFMC FSSI score indicates that the New England fishery is below its potential maximum sustainability level, but also indicates that in general, the overall fishery has improved from 2010. This is part of a larger trend where at the end of 2020, 47 stocks have been rebuilt. In 2019, the number of stocks listed as subject to overfishing reached an all-time low.⁸

⁸ Status of Stocks 2019. Annual Report to Congress on the Status of U.S. Fisheries. July 2020. Available online at https://media.fisheries.noaa.gov/dam-migration/2019_status_of_stocks_rtc_final_7-15-20.pdf

Table 4.2.3 NEFMC managed stocks in 2020

Stock	Overfishing	Overfished	B/Bmsy	FSSI Points
Atlantic herring - Northwestern Atlantic Coast	No	Yes	0.29	2
Sea scallop - Northwestern Atlantic Coast	No	No	2.72	4
Acadian redfish - Gulf of Maine / Georges Bank	No	No	1.54	4
American plaice - Gulf of Maine / Georges Bank	No	No	1.16	4
Atlantic cod - Georges Bank	Yes	Yes	0.07	1
Atlantic cod - Gulf of Maine	Yes	Yes	0.06	1
Atlantic halibut - Northwestern Atlantic Coast	No	Yes	0.03	2
Haddock - Georges Bank	No	No	3.65	4
Haddock - Gulf of Maine	No	No	10.35	4
Pollock - Gulf of Maine /Georges Bank	No	No	1.7	4
Red hake - Southern Georges Bank / Mid-Atlantic	Yes	Yes	0.37	1
Silver hake - Gulf of Maine / Northern Georges Bank	No	No	3.1	4
Silver hake - Southern Georges Bank / Mid-Atlantic	No	No	0.64	3
White hake - Gulf of Maine /Georges Bank	No	Yes	0.5	2
Winter flounder - Georges Bank	No	Yes	0.24	2
Winter flounder - Gulf of Maine	No			1.5
Winter flounder - Southern New England / Mid-Atlantic	No	Yes	0.18	2
Witch flounder - Northwestern Atlantic Coast		Yes		0.5
Yellowtail flounder - Cape Cod / Gulf of Maine	No	No	0.62	3
Yellowtail flounder - Southern New England / Mid-Atlantic	No	Yes	0.05	2
Little skate - Georges Bank / Southern New England	No	No	0.87	4
Winter skate - Georges Bank / Southern New England	No	No	1.52	4
Goosefish - Gulf of Maine / Northern Georges Bank	No	No	1.31	4
Goosefish - Southern Georges Bank / Mid-Atlantic	No	No	1.55	4
Spiny dogfish - Atlantic Coast	No	No	0.67	3

Prepared from NOAA Fisheries⁹

⁹ National Marine Fisheries Service - 2020 Status of U.S. Fisheries. Table A. Summary of Stock Status for FSSI Stocks. Available online at:

<https://media.fisheries.noaa.gov/2021-05/2020%20SOS%20Stock%20Status%20Tables.pdf?null>

5. Conclusion

In conclusion, the most recent economic data available from NOAA indicates that the total economic contribution to the NH economy from the marine fishery is \$125 million with approximately 70% being due to commercial activity and 30% due to recreational activity. Since 2010, the economic contribution from marine fisheries has been relatively stable with indications of increased job activity occurring throughout the entire economy attributable to this area of the economy. For commercial fishing, NH has historically been dependent on the lobster harvest and that dependence has only increased with time, now accounting for over 90% of all harvested value.

In the overall region, seafood harvest by weight is down due to tighter quotas to assist in fishery stock rebuilding. Up until this past year, the landed value of the commercial harvest has been increasing slightly every year driven primarily by lobster harvest. Currently the lobster population is projected to remain abundant over the next decade which should help to support the commercial fishing industry and if rebuilding plans are successful for other commercial species, like cod, the industry could see further growth.

In the overall region, the recreation industry catch is most likely down from a decade ago, however it is not clear if the catch volume attributed to NH-based angling effort has changed from a decade ago. This is because collecting recreational catch data is challenging and NOAA has provided uncertainty estimates when interpreting the values of its estimated recreational fishing effort.

In summary, the marine fishing industry (both recreational and commercial) makes a substantial contribution to the NH economy and supports up to 3,200 NH jobs in a variety of industries including wholesale and retail trade. Research indicates a stabilized-to-improving environment, which may serve to further improve the abundance of marine species available to both commercial and recreational fishers which would help to grow the contribution of this sector to NH's economy. Additional economic data and assessment is necessary to more accurately measure the health and economic value of commercial and recreational fishing in NH.